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THE PRACTICAL ENGINEER

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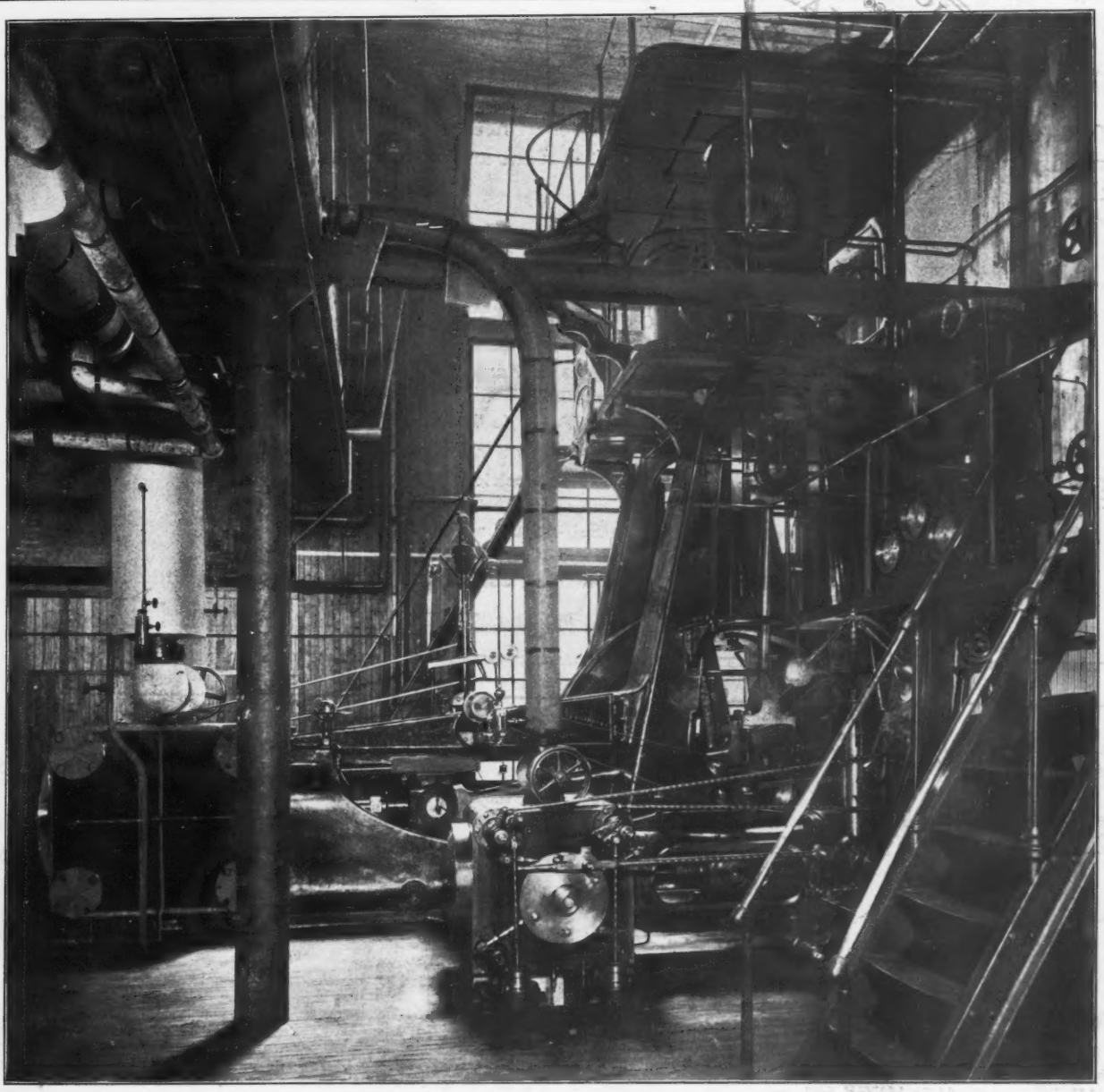

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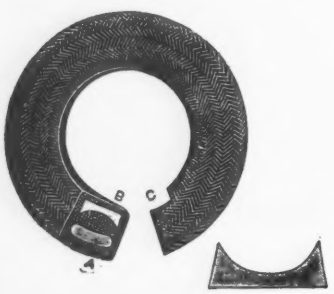

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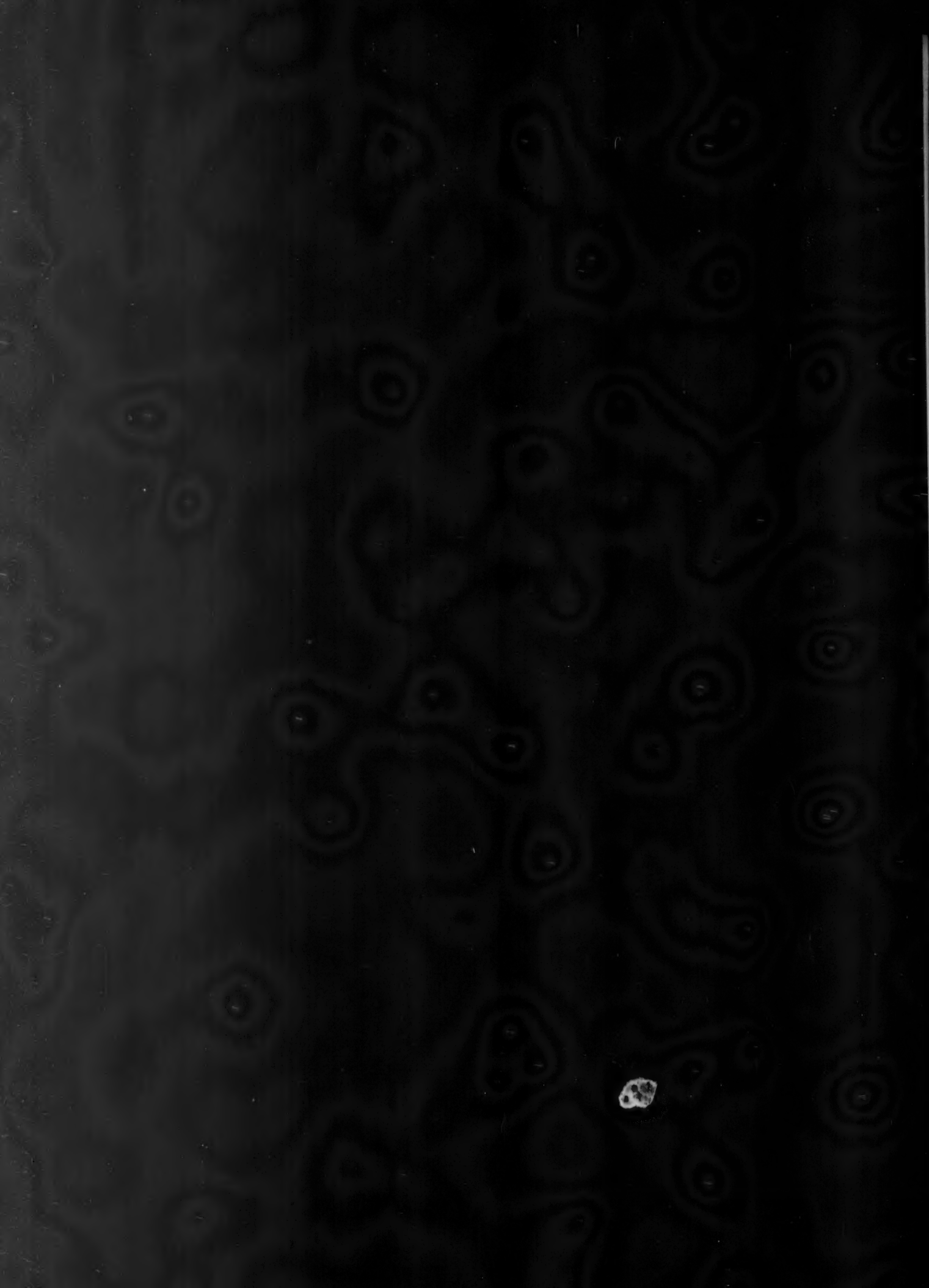

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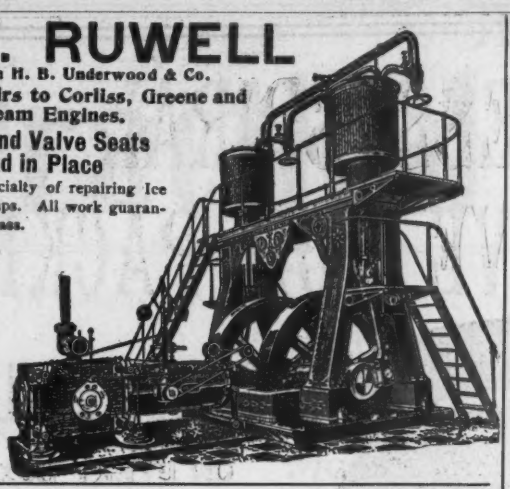

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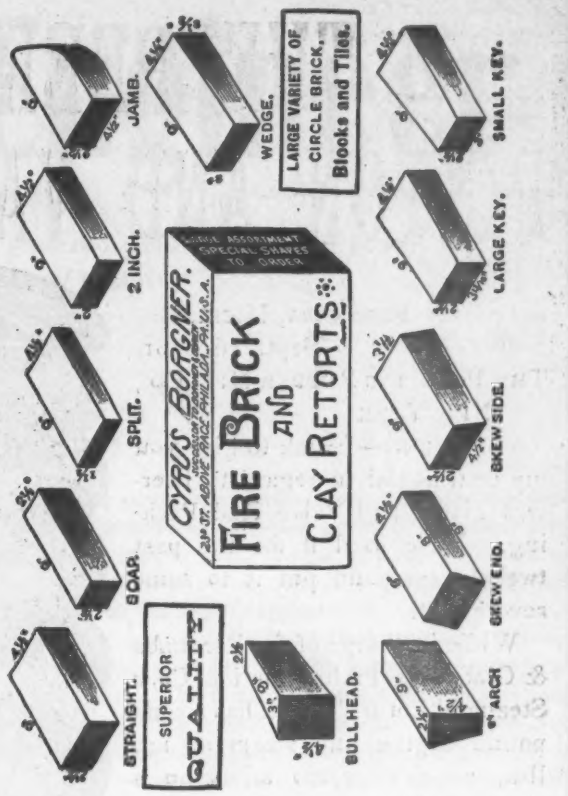

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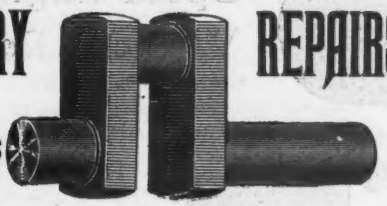

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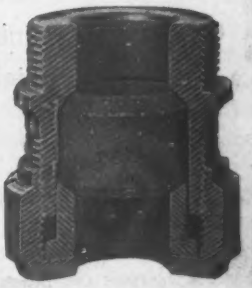

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The
Practical Engineer

A monthly journal, devoted to the economical generation and utilization of power and to the interests of stationary engineers

VOL. VII PHILADELPHIA, DECEMBER, 1903 No. 11

More About Progress

By W. H. WAKEMAN.

Several months ago I called attention, through THE PRACTICAL ENGINEER, to what may or may not be called progress in steam engineering, according to the standpoint from which the matter is viewed. Since that article appeared I have given the subject further consideration, and wish to present more ideas along the same line of investigation, the object of which is to find out whether all moves made by engineers are really forward, for some of them may be in the opposite direction.

Take for illustration, facts in the plant of which I have charge. One of the engines was built ten years ago, the stroke of which is practically two and one-half times the diameter of cylinder. This engine revolves seventy-five times per minute, and drives in addition to other machinery, a Westinghouse generator producing current at 110 volts potential for operating incandescent lamps The engine was made "on honor," and although is now an old fashioned type, it has several excellent features. Among other things the piston is worthy of attention, as it is well designed so that the engineer can keep it in its proper place. The packing rings are made in comparatively short sections, held in place by springs that show but little wear after their long term of service. The follower plate is a separate part of the piston, held in place by follower bolts in the usual way. When these are removed and the follower taken off, it discloses four centering screws, with a jam nut on each, by means of which the piston rod may be placed exactly in the centre of cylinder. Once each year the cylinder head is of this engine is taken off, the follower removed, and measurements taken to determine the exact position of piston rod. It is usually found a small fraction of an inch below the centre, and is put back in its proper place.

I have another engine that was installed less than one year ago, the stroke of which equals the diameter of cylinder, and it revolves 300 times per minute. The piston of this engine is called "solid," although it is really hollow in the centre, therefore the term "solid" in this case means that the spider and the follower plate are in one casting. There are two packing rings, each one-half inch square, that are sprung over the end of piston into two grooves prepared to receive them. The piston is a sliding fit in the cylinder, and of course the packing rings prevented steam from blowing past it, or to use a common expression among engineers, from "blowing through the piston."

Now when this piston rod is found to be below the centre of cylinder, which is sure to be the case sooner or later, how shall I proceed to remedy the evil? So far as I can see it will be necessary to get a new piston, and it is quite possible that the owners will object to the expense of it.

The point that is intended to be brought out is as follows: The older engine is out of date, yet the piston rod can be kept central indefinitely. The newer engine is a modern machine, yet there is no way provided for centering the piston rod. All modern machinery is supposed to represent progress, but if this supposition is correct, then the above mentioned case is an exception to the rule, or in other words, progress seems to have been made in the wrong direction, as the old machine is made so as to admit of finer adjustment in a vital part than the new one.

This high speed engine carries an excellent generator on its crank shaft, and as it is located only a few feet distant from the belt-driven generator previously mentioned, it affords a good opportunity for comparison of the belt driven and the direct connected generators in practice.

It is perfectly safe to say that the oil required by the latter for one day will supply the former for one week, including the engine and the necessary countershaft, in order to make a fair comparison.

The care and attention required to keep the two types in operation, so far as attendance and repairs are concerned, are in about the same proportion, and when the cost of steam is considered, the result is easily in favor of the low speed engine. I am quite sure that the direct connected unit cost more than the belted outfit, for equal capacity, therefore no progress can be reported in the matter of first cost, which is always considered an important item.

To offset these disadvantages there remains but one more point to be brought forward, and that is the matter of floor space required by the two types, and here the modern machine is in the lead, for it requires less than one-half of the space occupied by the other.

Having conceded this point what does it amount to? I am quite sure that if we except central portions of a few of our larger cities, 75 per cent. of the manufacturing plants, where the power department is crowded into the closest possible quarters, contains space that is either not occupied at all, or else is not used for any valuable purpose.

The point I wish to make clear in this connection is, that it is not good business policy to pay an extra price for machinery of any kind, because it occupies but little space, and then fail to make good use of the space saved, or it may be proper to call it purchased, in this way.

I have no desire to be considered "behind the times," but present these facts just as I find them, asking readers to carefully consider the same, and see if there is not some excuse for believing that every change made in the design and construction of steam and electric plants, is not an improvement, therefore the many changes announced and practiced from time to time do not denote proportional progress.

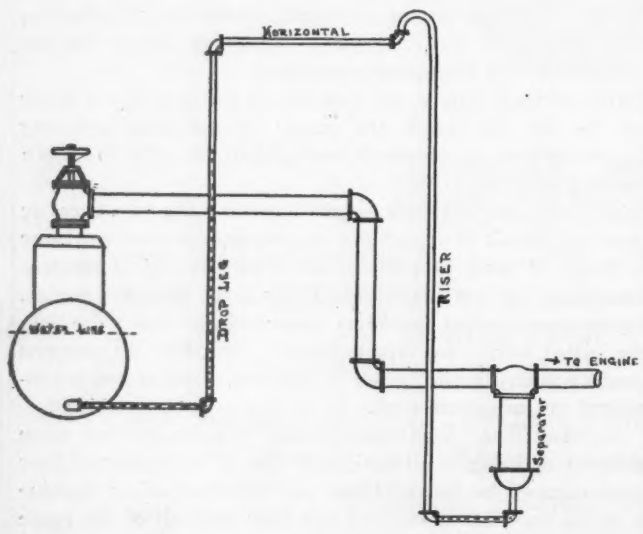
The Steam Loop

It is important, both theoretically and practically, not to allow any water to flow into the steam chest of an engine with the live steam generated at the boiler. As all boilers, to a greater or less extent, do not furnish dry steam but steam holding small particles of water in suspension, the usual method of separating this water from the steam is by means of a separator.

This water, which with a good boiler is usually about 4 per cent. of the total weight of steam and water passing through the main steam pipe, is thrown down to the bottom of the separator and is taken care of in several ways. It is sometimes freed by hand, more often a steam trap is used, and in places where it can be satisfactorily applied, the steam loop is used.

This water caught in the separator is pure, and should, wherever possible, be returned to the boiler, and the steam loop is undoubtedly the most simple device used by engineers to return this hot water to the boilers without loss.

The loop consists principally of three pipes, the riser, the horizontal and the drop leg, and usually consists of pipes varying from $\frac{3}{4}''$ to $2''$ in diameter. The horizontal must be a good distance above the boiler. The riser is connected to the bottom of the separator and the drop leg must be connected to the boiler below the water line.



The operation of these three pipes is extremely simple. At the engine, the steam pressure is always less than it is at the boiler. If that is so, then the pressure of the boiler tends to force the water up the drop leg until the height of the water above the boiler is equal to the difference in pressure.

For example: Suppose the boiler pressure is 100 lbs. per square inch and the pressure at the engine is 95 lbs. per square inch. This makes a difference of 5 lbs. per square inch. This makes the water in the drop leg rise to about 15 ft. in rough numbers. This then causes a state of equilibrium throughout the loop and would stay that way if the riser contained a solid body of water, but it does not. It carries a mixture of water and steam, the weight of which is very much less than water, and allows it to operate for the following reason. Condensation in the horizontal pipe reduces the pressure and this causes the steam and water in the riser to rush upwards until they are discharged through the goose-neck connection. This, in turn, is condensed in the horizontal and the water of condensation runs into the drop leg, increasing the height of the water in the drop leg. This causes more pressure than the boiler pressure can maintain and the water then runs into the boiler.

The height of the horizontal above the boiler is not important, only that it must be high enough, at least 5 ft. for every pound drop between the boiler and separator. In some places where the difference in pressure is considerable, it may not be convenient to erect a drop leg high enough to overcome the difference in pressure, but in high buildings that are fitted with air shafts, it can easily be accomplished, and there are few shops or factories where the necessary pipes cannot be run through the rooms until the required height is secured.

The facts in its favor are that it contains no moving parts, it will last indefinitely, its first cost is low, it requires no attendance, and it not only saves heat, but puts pure water back into the boiler.

A Large Water Power Plant

The triangular section, between Glen Falls, Schenectady and Albany, New York, containing a population of about 300,000 and many large manufacturing enterprises, will soon have one of the largest water power plants in the country, from which to get its electrical power. It is now nearing completion on the Hudson River, about 8 miles southwest of Glen Falls. The river here, caught between two hills of the Adirondacks, is by means of an immense masonry dam raised fifty feet above its old level and a fall of eighty feet is available for the turbine wheels. The average flow over the dam is between 6000 and 7000 cubic feet per minute.

The dam was begun in June, 1900. It is 1820 feet long and has a maximum height of 100 feet. It is carried down to bed rock, built of solid masonry, and anchored at each side in the mountain ledges. The power is obtained by ten pairs of turbine wheels running on horizontal shafts; eight pairs each, having a capacity of 5000 horse-power, and two of 3400 horse-power each, which makes a capacity of 46,800 h.p. The larger machines are directly connected to 2500 kilowatt electric generators, and the two smaller ones run 2000 kilowatt machines. The electrical output is, therefore, 32,000 h.p. The water is carried to the wheels through ten steel tubes twelve feet in diameter.

The current is generated at about 2000 volts and raised to

30,000 volts for transmission. This is done by thirty transformers, designed to operate either at 15,000 or 30,000 volts. The brick power-house is of the most substantial construction, its foundation of concrete masonry being bedded in rock. It is 392 feet in length and 70 feet wide. There is already such a demand for power that, although only the foundations and floor of the power-house are finished, two 2000 kilowatts and one of the 2500 kilowatt machines are regularly supplying current. Although only 60 feet of head is now available, the generators, owing to the large excess of capacity of the turbines, are carrying the loads satisfactorily.

The Hudson River Water Power Company, who are building the power-plant, also own several local electric companies, and one of the first uses of the water power current will be to replace the steam driver stations. The same company also owns another water-power station on the Hudson just below Mechanicville. This plant has a capacity of 7000 electrical horse-power, which, together with the new plant, will make 39,000 electrical horse-power available. One large manufacturing concern has already contracted for 10,000 h.p. so that the success of the undertaking is assured.

Methods of Increasing the Horse-Power of the Steam Engine

It often happens that an engine, which was originally of sufficient power to do the work of a manufacturing establishment, becomes unable to do the work, owing to increased demand for power. The usual method of increasing the engine power of a plant is, of course, either to replace the old engine with a larger one or add to the number of engines. It sometimes happens, however, that owing to circumstances usually on account of time it would take to replace the engine, or the lack of space which would be required for the new engine, it would be advisable, if possible, to increase the horse-power of the present engine.

Under such circumstances, there are five ways by means of which the horse-power can be increased, as follows:

1. Raise the boiler pressure.
2. Increase the speed of the engine.
3. Increase the diameter of the cylinder.
4. To compound the engine by adding another cylinder.
5. Add a condenser, if the engine ran non-condensing.

The first plan, of increasing the boiler pressure, is very often used, and if economy is of no consideration, it may be done, provided, the boilers can stand the added pressure. The effect of increasing the boiler pressure on the indicator diagram is shown in Fig. 1. Assuming that the engine cuts off at the same stroke, the shaded portion of the diagram indicates the increase of horse-power. The loss of economy in this case is principally because the steam is exhausted at a much higher pressure than formerly, which loss of pressure necessarily means loss of work.

The second plan, of increasing the speed of the engine, is also frequently used. If belted to a counter shaft, it would be necessary to have a new counter pully, so that the speed of the shafting may remain the same. The effect of speed of the engine is not apparent on the indicator diagram, but it will use more steam, and, as a consequence, more fuel will be consumed. If the speed of an engine is increased, great care must be taken that the fly-wheel is not run above its safe speed, as this is a frequent cause of fly-wheel accidents.

The third plan, of replacing the old cylinder with one of larger diameter, increases the power considerably, as the power

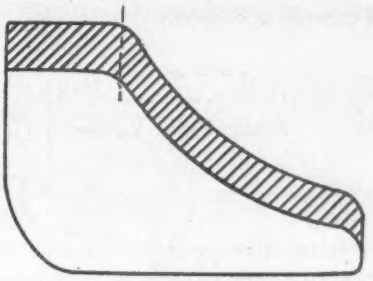


Fig. 1

of an engine, if other conditions are the same, varies with the square of the diameter. The increase of area of the piston has no effect upon the indicator diagram, but will use more steam and fuel. When the diameter of the cylinder is increased, it involves the necessity of a new piston, steam chest and valves. The diameter of a cylinder should never be increased more than 2", because the other parts would be too light and be liable to spring.

The fourth plan of adding another cylinder with suitable changes in valve gear, is perhaps the most economical, but the cost of making the change would be considerable. It can only be successfully used when the engine has already been run condensing, as the initial boiler pressure would otherwise have to be raised considerably in order that each cylinder should do its required amount of work. The most usual way to compound an old engine is to make it a tandem compound, when great care must be taken that the combined horse-power of the two cylinders shall not be too great for the reciprocating parts.

The fifth plan, of running the engine condensing, if it has run non-condensing before, is the most safe and practical method for a moderate increase of power. The only question involved is the installation of the proper condensing apparatus,

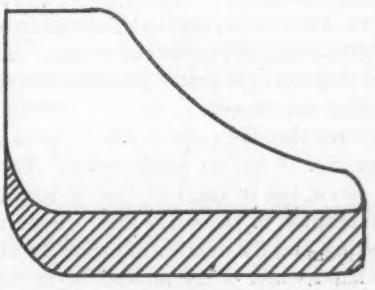


Fig. 2

which, however, should be placed where there are large quantities of condensing water, as otherwise the high cost of this water would make it an expensive method.

The effect of condensing the steam is shown on the indicator diagram in Fig. 2; the shaded portion, representing the in-

crease of power when using the same amount of steam from the engine.

Under no circumstances should any of these five plans be used unless there is a thorough investigation of the conditions, as a steam engine is not supposed to be run at a greater speed or presure than that for which it was originally built, but there are times and circumstances when it becomes necessary, regardless of expense or economy.

Steam Plant Valves

Part III.

By R. T. Strohm.

Boiler stop valves often need to be closed almost instantly, as for example, when a tube ruptures so as to necessitate cutting the boiler out of service. If the steam main is fitted with the ordinary hand-operated valve it is then necessary to climb up on the boiler and close the valve by hand, which may be a matter of several minutes. In emergencies of this sort, time is a potent factor, and so the automatic non-return stop valve has been designed to close connection with the boiler in case the pressure in the boiler falls below that in the steam main. This it does automatically at the moment of accident.

However, a break in the steam main is not an uncommon accident, and in such an event it becomes necessary to shut off the flow of steam from the boilers. A valve for accomplishing this purpose is known as an emergency stop valve. Such a valve is also preferably automatic in its action, though there are valves of a quick closing type which must be operated by hand.

In some of the very large power plants recently built, valves varying from two feet to five feet in size have been installed. To close these valves by hand would require considerable time, and as they are frequently compelled to be used as emergency valves, it has been found necessary to use mechanical means of closing them. In one type, the valve stem is fitted with gears, driven by a small electric motor attached to the valve yoke, as shown in Fig 15. It is evident that by means of proper wiring electrically operated valves may be controlled from any point, far or near, and this feature makes them desirable for use on steam mains, as throttle valves, stop valves, on receiver piping, and so on. In other types a cylinder is rigidly attached to the valve yoke, and in this cylinder works a piston which is directly connected to the valve stem. This piston may be driven by steam, air, or water pressure, according to whichever is the most convenient to use.

It will be noted that the valve in Fig. 15 has an outside screw, while that in Fig. 16 has an inside screw. The advantage of the outside screw lies in the fact that it forms an indicator, showing the position of the valve disk. For the spindle rises without rotating, and the number of inches by which it projects beyond the hand wheel is the number of inches the gate has risen. With the inside screw, it is necessary to use some form of indicator or pointer to show the position of the valve. Furthermore, with the outside screw, the thread is seldom in contact with the steam, and is always readily lubricated and kept in good condition, and it avoids the necessity of cutting a thread in the wedge or disk.

Having passed through the steam main to the engine, the steam now meets the throttle valve, by which its admission into the steam chest is regulated. The throttle valve consists either of a gate valve or a globe valve, according to the size of the engine. The smaller units are fitted with globe valves, the larger with gate valves, as previously described. As a usual thing, the throttle valve is placed at the lower end of a vertical steam pipe and consequently all condensation which occurs in the pipe collects in the valve when it is closed, which is the case when the engine is shut down. A drip should always be provided on a valve so placed, to provide for the removal of the condensation before opening the valve. This precaution is necessary to avoid accidents by water hammer.

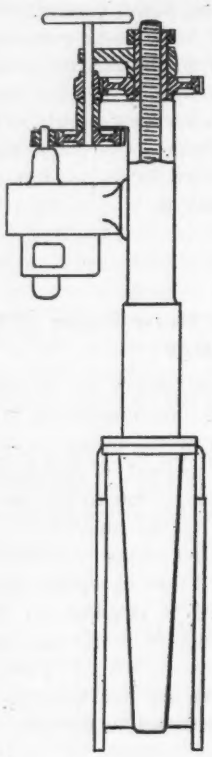


Fig. 15

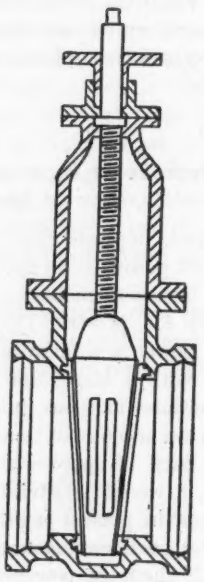


Fig. 16

In the use of globe and angle valves there is considerable difference of opinion regarding the placing of the valve. That is, whether the steam pressure should come under the disk, so as to force it away from its seat, or over the disk, so as to force it toward its seat.

Manifestly, if a valve is so placed that the pressure is exerted above the disk, or on the stem side, the packing about the valve stem will be subject to the continuous action of the steam, so that leaks are likely to develop more rapidly than when the pressure is on the other side of the disk, since in the latter case there is steam pressure on the packing only when the valve is open. In many valves, also, it is impossible to repack the stuffing boxes around the valve stem until steam pressure is shut off, which may necessitate a shutting down of the plant. This objection is overcome in improved designs of valves, in which the collar holding the disk forms a tight joint against the valve bonnet when the valve is fully opened, thus allowing the stem to be packed while the valve is under pressure One advantage of having the pressure act so as to force the disk to its seat lies

in the fact that the valve is less liable to leak in this position; while some engineers claim that if the steam acts continuously on the packing, the latter is kept soft and moist and does not need to be renewed so frequently.

On the other hand, if the pressure acts on the under side of the disk or on the side away from the stem, then when the valve is closed the entire pressure upon the disk is borne by the threads on the stem. This cannot be made a ligitimate objection, since valves rarely, if ever, are known to fail by shearing off of the threads. A valid objection, though, is the liability to leakage caused by the contraction. While the valve is open, a portion of the stem at least is subjected to the heat of the steam. When the valve is first closed it may be tight. But as condensation collects around the stem and on the disk, these cool, and a leak is very liable to occur, especially if the pressure aids in forcing the valve disk from its seat. The opposite would be true if the pressure came above the disk.

Where steam mains of considerable size and length are used, it is extremely undesirable to admit the full pressure from the qoiler by the opening of the boiler stop valve, since this would invite accident through rapid expansion. In such cases it is necessary to use a by-pass valve, by means of which a small amount of steam may be passed around the closed stop valve into the main, for the purpose of warming the latter. This by-pass valve is commonly attached directly to the stop valve, and controls a passage leading from one side of the disk to the other, this passage being cored in the main valve body. In other cases, this by-pass valve is placed on a small pipe tapped into the main on opposite sides of the stop valve The by-pass valve may be either a globe valve or a gate valve.

If the condensation once gets into the cylinder in any considerable quantities it may cause serious trouble. Many engines are therefore provided with relief valves. The cylinder relief valve is in reality only a small safety valve of the spring-loaded class, which opens to discharge steam and water in case the compression reaches too high a pressure. This valve is in direct communication with the clearance space.

Another type of relief valve used in all condensing plants is that illustrated in Fig. 17, known as an atmospheric relief valve. It is attached to the exhaust pipe or to a branch pipe in open connection with the exhaust pipe, between the engine

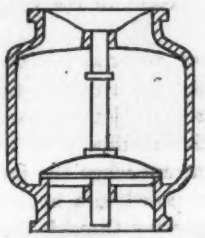


Fig. 17

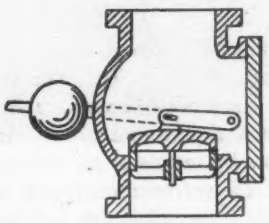


Fig. 18

and the condenser. If for any reason the pressure in the condenser rises, through failure of the air pump or the breaking of the vacuum, then the exhaust steam lifts this relief valve and escapes into the atmosphere until the condenser can be put into working order.

In many plants, instead of using a condenser, the engines are run non-condensing and the exhaust steam is used for heating purposes. In such cases it is desirable to maintain a constant back-pressure, and to provide for this the back-pressure valve is used. It is similar to the atmospheric relief valve previously described, except that it is furnished with an adjustable weight and lever as shown in Fig. 18, by which it can be set to open at any desired pressure. It is placed on the exhaust line of piping.

Sometimes it is found that the exhaust steam is not sufficient for heating purposes. Then it becomes necessary to make up for the deficiency by using live steam from the boilers. However, as this is high-pressure steam, and the system is designed

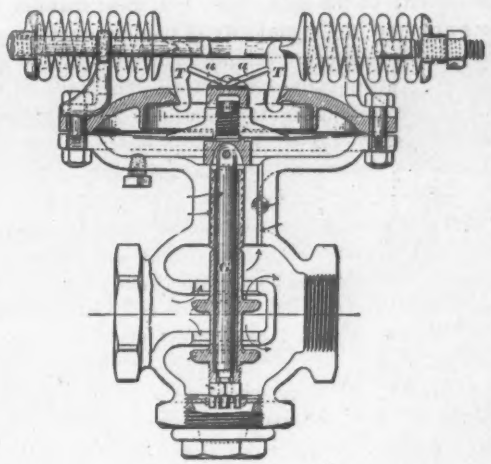


Fig. 19

for low-pressure heating in connection with the exhaust, it is evident that the pressure of the boiler steam must be reduced to that of the exhaust before entering the heating system. This is accomplished by the use of the regulating valve such as that shown in Fig. 19. It consists of a balanced throttle valve on a stem *G*, the position of whose disks is regulated by a coiled spring which is in turn connected to a diaphragm through a series of toggles *a*, *a*, and levers, *T*, *T*. The steam on the low-pressure side of the valve acts on the diaphragm which determines the amount of opening of the valve, through the series of levers shown. The steam, in passing through the valve, is thus throttled or wire-drawn and so reduced to the desired pressure. This pressure can be varied by changing the tension of the spring, but having once set the spring for a certain pressure, that pressure is constantly and automatically maintained on the outlet side of the valve. The wire-drawing to which the steam is subjected may dry it if it is not too wet, or may superheat it, if it comes from the boilers fairly dry. Reducing valves may be used, also, to reduce the pressure of steam which is to drive engines.

Functions of the Fly-Wheel and Governor

The functions of the fly-wheel are three:—

1.—To store up work received in one part of the stroke and give it out in another part of the stroke, when the pressure on the piston has grown less after cut-off.

2.—To equalize variation in the leverage of the pressure of the piston upon the crank. That is, when the engine is on centre, the pressure of steam cannot exert any turning effect, but when the crank and connecting rod are at 90°, the pressure of steam is best utilized upon the crank.

3.—To give out or absorb work when the load upon the engine is varied suddenly.

The fly-wheel is therefore an accumulator, and the steadiness of an engine depends upon the weight of the rim of the fly-wheel and its diameter. For any given regulation, either a large wheel with a light rim, or a small wheel with a heavy rim, may be used. The objection to a large wheel is the space it occupies and the complication in the foundation which it causes. A large wheel is also more likely to break owing to the high velocity of the light rim. For these reasons, smaller diameters are used in the majority of modern engines, and the diameter of wheel usually roughly approximates four times the stroke. In early engines 35-foot fly-wheels were met with, but now 20′ is considered a large diameter and in centre crank high speed engines 7′ has become a large size.

The use of a fiy-wheel as a regulator is quite different from that of the governor. The fly-wheel regulates all the variations in steam pressure on the piston, all the variations of pressure upon the crank-pin, and all the variations of work done by the engine during one revolution. All these small variations, which are too small to bother the governor with, are attended to by the fly-wheel, that large heavy wheel moving with a high velocity.

For permanent variations, where the work to be done by the engine is increased or diminished, the capacity of the fly-wheel for storing work or giving it out is exhausted and the engine will either increase or decrease its speed. This is where the governor comes in. It must then adjust its mechanism and valves so that it can do the new amount of work required.

Generally speaking, the more quickly the work of an engine is varied, the heavier must be the fly-wheel for a given diameter, if an even number of revolutions is desired. Of course, in a great many factories it is not necessary to obtain such a fine system of regulation, but in electric plants this regulation of speed is very important. It is best not to give the governor too much to do, because, with a fly-wheel that is too light, the governor will jump up and down, or in and out. This is called hunting, as the governor is continually trying to hunt every little irregularity in one revolution, which the fly-wheel should attend to.

The kind of work that an engine does often determines the weight of the fly-wheel required, as, for instance, an engine that would be very well suited to run an electrical plant with a steady load, would be entirely unfitted for electrical railway work where the load is continually varying.

Sometimes, as in rolling mill engines, the amount of work done varies from no load to full load in a few seconds, so that rolling mill engines have fly-wheels weighing from 30 to 50 tons.

Engines with two or more cranks do not have such heavy or large fly-wheels, because, when one crank is on dead centre, the others are in their most favorable position to do the work, and thus the internal variations are miminized.

Marine engines require no fly-wheel as the load is always about constant and regularity of speed is not a requirement. The locomotive requires no fly-wheel since the driving wheels and speed of the train serve this purpose, and the cranks are at 90°, a feature which always greatly diminishes the weight of fly-wheel required in a stationary engine.

How the Incandescent-Lamp Filament is Made

The filament of the modern incandescent lamp represents the result of years of thought and experiments by a number of famous electrical men of the past, and of the present time. The modern art of making successful incandescent lamps dates back to about 1880. Edison, after a long investigation of the relative values of various substances for use as lamp fllaments, decided on the use of carbonized strips of bamboo. Filaments of this kind were used in connection with Edison lamps for nearly fifteen years. At an early date, platinum wire was used in the form of spirals or loops. Current was allowed to flow through the wire, which brought it up to incandescence. The results were not satisfactory because of the disintegration of the wire and because of the great expense of the material. Other substances used for filaments were carbonized strips of cardboard, small carbon rods, carbonized silk thread, etc..

The modern lamp contains a filament made up of carbonized threads of cellulose. They are often called "squirted filaments." The material from which the filament is made is mostly fine absorbent cotton. This is pulped and then dissolved in zinc chloride, producing a viscous, semi-transparent liquid. The solution is evaporated at about the constituency of thick molasses, and then squirted through a forming die to a vessel containing alcohol. It hardens in the form of a long thread,, and can be handled. It is washed, dried, and cut into proper lengths. The pieces of thread are carbonized at a very high temperature, and are kept out of contact with the air during this process. The carbon filaments thus obtained, after being measured and sorted, are ready for the flashing process.

In case one portion of the filament has a higher resistance than other portions, that portion will glow more brightly when current is passed through it. In order to make the filament as homogeneous as possible, and to provide a dense carbon plating on its surface, it is allowed to come up to incandescence when in a jar containing hydrocarbon vapor. The heated surface of the filament decomposes the vapor, and carbon is deposited on all portions of it, but more plentifully on the portions, which, because of their high resistance, are at a higher temperature than other portions. The resistance of all portions of the filament is thus made uniform. A firm, hard coating is given it, which greatly increases its durabilty. The process is discontinued when the filaments become of the proper resistance.

The finished filament is mounted on the ends of two small pieces of platinum wire. The method often used is to apply a paste made of carbon and molasses to the joints between the filament and platinum wires. Another method is to heat the junctions by means of an electric current when the junctions are under a hydrocarbon liquid, or exposed to a hydrocarbon gas. Platinum wires are used for passing through the glass, because platinum and glass have similar co-efficients of expansion. If this was not so, either the glass would be cracked or else air would be allowed to pass into the lamp. At the other ends of these two short lengths of platinum wires, copper wires are connected, which run to the base.

The air is exhausted by means of air pumps. After a certain exhaustion is accomplished, the remaining oxygen is in some processes, chemically absorbed by introducing into the lamp bulb a gas from a small piece of phosphorous. The lamp is illuminated during the last of the exhausting process so as to drive the air from the filament. The lamp, after exhaustion

and test, is mounted on its base, measured, billed, and prepared for market.

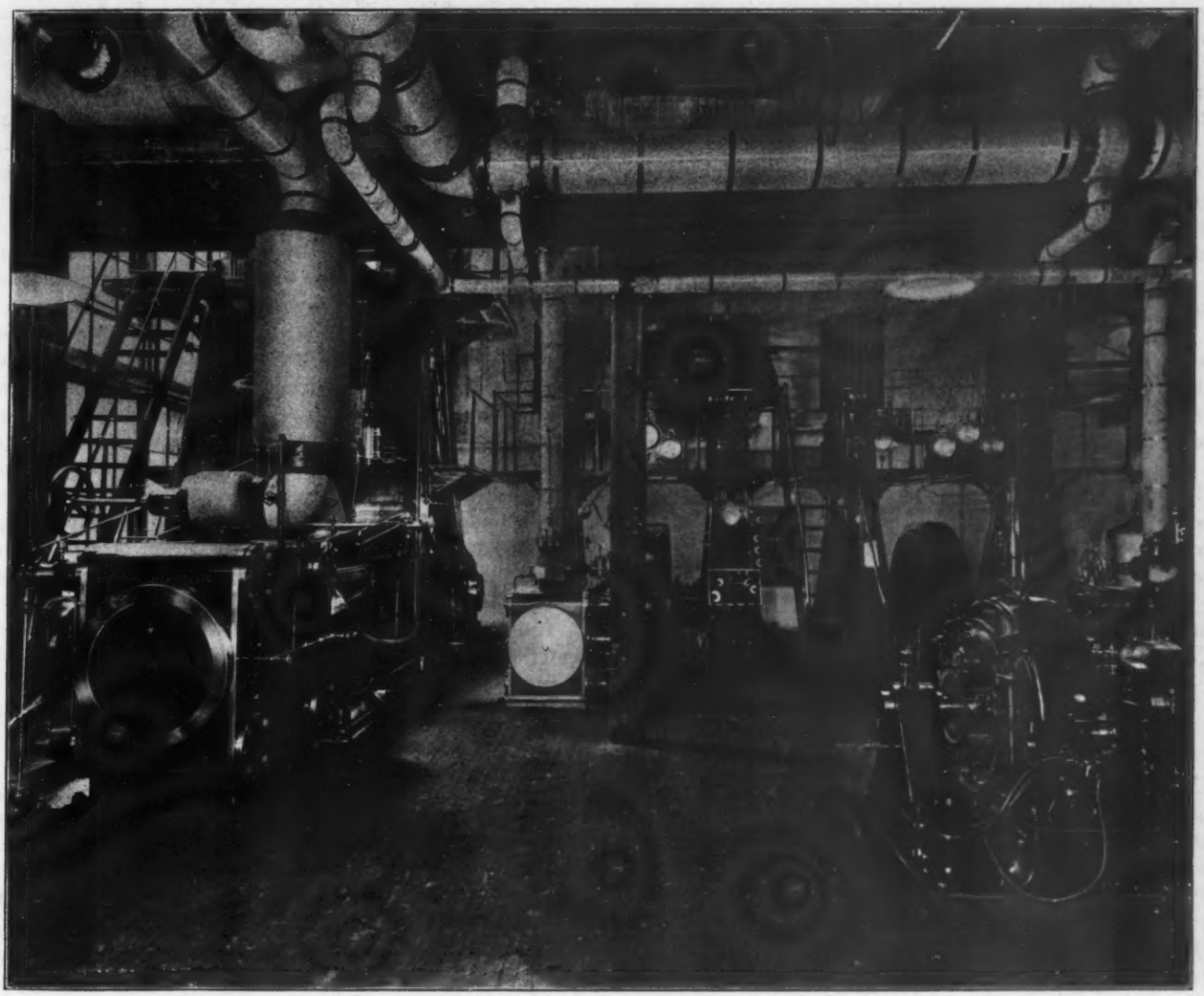
Lamp filaments are made in many forms, there being the single loop, single coil, double loop, and coils, etc. Lamps are designed and constructed to be used in connection with lines having a low E. M. F., up to lines having an E. M. F. of 250 volts.

The light-giving qualities of a lamp change with the time that it is burned, and with the variations of normal voltage.

vegetables, that are destroyed by the frost, must be kept at a temperature above 32°, and such articles of food as meat and poultry must be kept very cold.

The plant throughout is extremely well equipped with duplicate machinery, and great care is exercised continually to keep the plant in the finest possible condition; the large engine all the way down to the smallest tank, being painted or burnished with the same degree of care.

The boiler room consists of two 200 h.p. retuyn tubular



General Arrangement of Engines, Delaware Freezing Co.

The Mechanical Plant of the Delaware Freezing Co.

A very interesting plant, which thoroughly shows the application of artificial refrigeration, is that belonging to the Delaware Freezing Co., which is located at American and Callowhill Streets, Philadelphia. It consists of a combined plant for making ice and for the supply of cold to a large number of cold-storage rooms which are situated on the upper floors of the same building.

The ice capacity of the plant is 65 tons per day, and the temperature of cold-storage rooms are kept at different temperatures, varying from 35° above down to 15° below zero. Each room has a different temperature, because fruits and

boilers, fed by two duplex pumps, 6 x 4 x 6, one of which is a Worthington and the other a Warren pump. The water is supplied from two feed-water heaters which heat the feed water to a temperature of about 205 degrees. The firing is done by hand, soft coal being used, the flue gases escaping into a chimney 5 feet in diameter and 135 feet high. Each boiler is equipped with a Just Mechanical Water Purifier.

The engines of this plant consist of three refrigerating machines, two of which are continually running day and night, and a high speed automatic engine directly connected to a generator. The refrigerating machines belong to the compression type, with two single acting vertical compressors, run by a horizontal

engine. The large machine was manufactured by the Frick Company, of Waynesboro, Pa. The compressors have an 18" stroke, and are driven by a 26" x 36" horizontal engine of the Corliss type, which runs at a maximum speed of 60 revolutions per minute. The two smaller machines were built by the York Manufacturing Co., the compressors of which have a 14" stroke and are driven by a 20" x 21" engine running at a maximum speed of 55 revolutions per minute.

The electrical unit consists of a 10" x 10" Ames engine, running 300 revolutions per minute, directly connected to a Milwaukee Electric Co. generator, having a capacity of 40 kilowatts.

The switchboard consists of two gray marble panels, on which are placed a Weston Ammeter and Voltmeter, Wirt Electric Co.'s starting box, 6 switches and a circuit breaker.

The dynamo furnishes all the lighting throughout the building, as well as to the 7½ h.p. motor which drives the brine agitator for the ice plant. Throughout the building, the electrical work is necessarily of the very best, as the conditions of the plant, especially in the cold-storage rooms, are very trying.

Both the steam and ammonia pipes are covered with Nonpareil Cork Covering.

In order to insure pure water for the manufacture of the ice, the steam from the engines is condensed. Before it reaches the condenser, the steam passes through an oil separator, is then passed through a skimmer to remove any impurities, reboiled, and again skimmed and the water is then used for ice.

The refrigerating part of the plant consists of two Duplex Gardner pumps, 14 x 12 x 12, 3 ammonia receivers, a fore cooler, 6 filters, a brine agitator, a Weston & Campbell brine cooler, and three duplex pumps, 7½ x 7 x 10, made by Worthington, Blair, and Laid-Law-Dunn-Gordon.

An elevator of the plunger type, used to lift the food products between the different floors, was installed by Excelsior Elevator Company.

Superheated Steam

The subject of superheated steam is one which the designer of both the reciprocating engine and the steam turbine should study with care since it now presents about the only feasible method of increasing the low economy of the steam engine. Professor Storm Bull, head of the department of mechanical engineering at the University of Wisconsin, at a meeting of the Western Society of Engineers, presented an interesting paper on this subject giving some historical notes and also the results of many tests made abroad and not a few in this country. A brief summary of the paper containing some of the most important points will be found of interest.

The use of superheated steam is not far from 75 years old. It was realized by the best authorities as long ago as 1830 that the principal loss of efficiency in the steam engine was due to the condensation of the steam in the cylinder, and from that time until now experiments and trials have been made to obviate the difficulty. The best remedy which now presents itself is the use of superheated steam. From 1830 to 1850 considerable interest seemed to attach to the question and much experimenting was done along this line. During the '50's and '60's the principal use that was made of superheated steam was for marine engines, and considerable application for it was found in this kind of work.

The advent of the compound engine and the high pressures which were then just coming into use were somewhat of a drawback to the use of superheat, for these two factors so greatly increased the efficiency of the steam engine that little attention was paid to the superheating of the steam. But now about the limit has been attained in the pressures to be used, and superheat therefore is the last resort for increasing the economy.

There are two principal arrangements of the superheater with respect to the boiler now in common use. The usual one is to install the coils of the superheater in the boiler setting proper. The second method is to install a separate furnace for the coils. Ordinary flange joints or couplings for the coils are impracticable, due to the high temperatures and the best arrangement of the steel piping, is to have it bent into coils similar to the ammonia coils in an ice machine.

The economy resulting from the use of superheaters has been demonstrated by hundreds of tests and the results of some of these trials are interesting to note.

In a series of tests made by Professor Schroeter of Munich in 1895, on a 75-horse-power engine using superheated steam, some astonishing results were obtained. The consumption of steam was only 10.4 pounds per indicated horse-power per hour, and the consumption per brake horse-power per hour was only 12.3 pounds—the engine developing 75 horse-power. The amount of coal used was only 1.3 pounds per indicated horse-power per hour. A series of tests was made on a small Schmidt engine by Professor Ripper, of England, in 1896, using saturated steam and steam of different degrees of superheat. The pounds of steam used per indicated horse-power per hour ranged from 39.33 to 17.58 for steam of zero degrees superheat, to steam of 306 degrees superheat, respectively, showing a great gain in economy.

Tests have also been made to determine the effect of the cutoff in the case of saturated steam and with superheated steam. The tests show that cutoff has very much less effect on the economy of an engine when running with superheated than when running with saturated steam.

It is a well-known fact that one of the principal losses of energy in a steam engine is the interchange of heat between the steam and the cylinder walls. This interchange of heat does not take place if the cylinder walls are dry, as they are in the case of superheated steam. It is this condensation of moisture on the comparatively cool cylinder walls during the admission that causes a great loss of energy in the use of saturated steam, while with the use of superheated steam condensation oftentimes does not take place until far along in the expansion.

In another series of tests made by Professor Schroeter upon a 250-horse-power compound steam engine in Ghent, Belgium, which shows the highest economy of any engine ever tested, it was ascertained that the actual gain in the economy due to a superheat of 204.4 degrees, based on equivalent consumption, was 13.3 per cent., and for 310.9 degrees was 26 per cent., which is a remarkable showing. By equivalent consumption of steam is meant the reduction of the number of pounds of superheated steam to the equivalent number of pounds of saturated steam at the same pressure, made on the basis of heat units.

To gain the highest degree of efficiency in the future it will be necessary to build boilers to produce a high degree of superheat and to design engines which can work under such tem-

peratures. According to the laws of thermo-dynamics, it it would be possible with 1700 degrees superheat to obtain an efficiency in the neighborhood of 80 per cent. But of course any such results are out of the question with any apparatus now possible to build.

Laced and Glued Belts

It is quite important that the person in charge of belts should know how to make a good joint, both laced and glued. Laced belts are rapidly going out of use, particularly main driving, and nearly all dynamo belts. Even when a belt is laced with a good composition lacing, it is not altogether reliable, and when belts are used for driving blowers for cupolas and dynamos, or for the main drive in a factory, the ends should be glued and riveted together. When the belt is quite thick, the joint may be made in the manner indicated in Fig. 1.

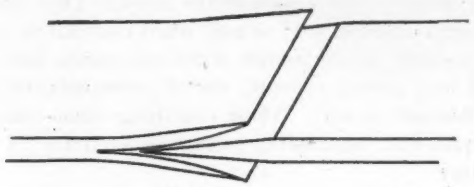


Fig. 1

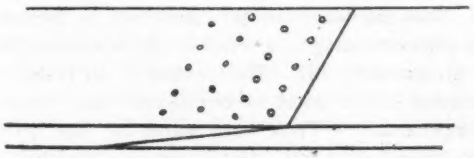


Fig. 2.

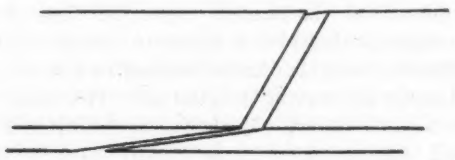


Fig. 3.

The ends of the belt are first drawn together by means of clamps, but should not be drawn up so tightly, but that it will have at least 3 inches sag in twenty feet. When making a splice, one end of the belt is split a distance equal to the width of the belt, provided it is not heavily loaded, otherwise make the length of the splice one and one-half times the width of the belt. The opposite end is then tapered down to a thin edge, beginning at such a distance from the edge that the tongue will just fit into the split end, otherwise the belt at the joint will be either too thick, or too thin. After fitting the ends, which should be done on a smooth flat surface, the ends of the belt where they come in contact with each other are given a coating of hot glue and pressed tightly together. Before the glue cools, shoe pegs may be driven in as indicated in the drawing in Fig. 2 These will tend to hold the layers of leather tightly together, the pegs becoming glued in place when driven in. After the glue has hardened so that there is no danger of disturbing any part of the joint, the copper rivets may be put in.

A thick belt, from four to seven ply, should be allowed from twenty-four to forty-eight hours after being entirely finished, in which to dry thoroughly and permit the glue to become hard before the clamps are removed. It is a good plan to allow the belt to run slowly, under a light load for a few minutes, before subjecting the joint to the full tension. The joint shown in Fig. 3 is suitable for belts of less thickness, the method of making the joint, however, is the same.

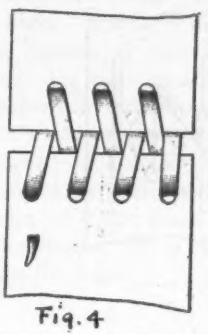


Fig. 4

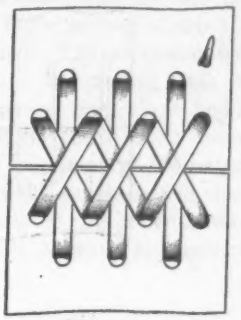


Fig. 5

There are many styles of laced joints in use which have given good satisfaction. Fig. 4 illustrates the so-called hinge formation of splice, which is used chiefly by mechanics and engineers in running small wheels at high rates of speed. Sometimes the union is made to economize in belt lacing, for it can be seen that a short piece will go a considerable ways. One piece of lace is worked with and inserted at one end, and after passing through the hole, is dropped down between the ends of the belting, to come up on the other side in the opposite hole. The operation is repeated back again and over and over until the width of the lacing is finished.

The lacing in Fig. 5 is designed for heavy work; that is, heavy work for belts of average width. The idea consists in a distribution of the strain quite freely, so as to bring the pull on the union at as many different points as possible.

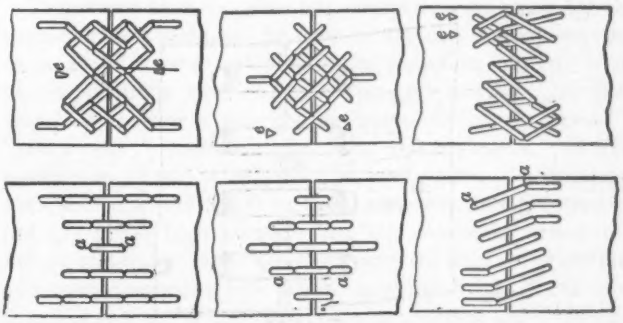


Fig. 6 Fig. 7 Fig. 8

The first operation consists in squaring off the ends of the belt, and this ought to be done only on a line marked with a scratch awl and a straight edge. Guess work at this point will ruin the whole splice. Use the straightedge to get the line true; then again with the straightedge mark off the first row of holes, say about an inch from the ends, to be followed with a marking of the next row another inch back, or a little more or less, according to the width and weight of the belt-

ing. It is a good plan, also, to mark off the distances between each of the holes, so as to get each hole in position to correspond with its mating hole on the other half of the belt. Now select a good, evenly cut, and well seasoned lace leather, and proceed to lace following the plan.

Fig. 6 illustrates another lace joint, the straight lacing should run next the pulley, while the crossed part represents the outside of the belt. The lace is begun at *a*, *a*, and laced each way out and return ending at *e*, *e*, on outside of belt.

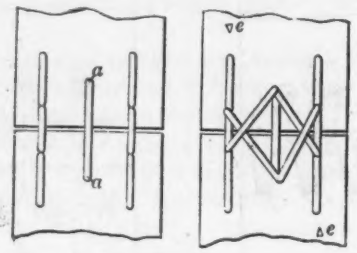


Fig. 9

Fig. 7 is somewhat similar, except that the lace is started on one side at *a*, *a*, and laced across the belt and back, ending at *e*, *e*. Fig. 9 represents a belt lacing for a narrow belt. Commencing at *a*, *a*, on the outside of the belt, it is laced each way ending at *e*, *e*, on opposite side of the belt. Fig. 8 represents a novel belt lacing for quarter twist belts. It is started at *a*, *a*, and ended at *e*, *e*, the parallel laces as usual being on the inside and the crossed lacing on the outside.

The most usual defect in lacing belts is shown in Fig. 10, where we see a good lacing made in the belt, but the ends of the belt have been improperly united as it was made without regard to the evenness of the butts. A straight line is extended through the joint and is indicated *b*. This line may extend through the middle of the lower section of the belt, but not through the upper. In the upper portion of the belt centre a deflection along line *c*, beginning at the point *a*. The

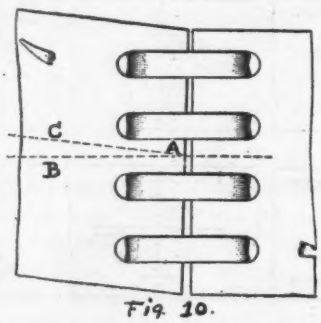


Fig. 10.

result is that we have a wabbly belt, that will run from one side of the pulleys to the other. The belt will slip and give endless trouble. All that is needed is to open the union, place the straightedge on the ends of the belt, mark off the holes straight across, and punch and lace accordingly. Also cut off the ends on the correct line indicated by scratching, with the straightedge as a guide, and then there will be no danger of getting a lacing like that shown in this sketch.

How Cold is Artificially Produced

If we purchase in the nearest drug store the little hand apparatus known as an "atomizer" it may be charged as usual with perfume, or, better still, with common ether. Hold the back of the hand before the nozzle and compress the bulb. A fine spray of the volatile liquid is thrown upon the flesh and rapidly evaporates, producing the sensation of cold; and if the process be kept up sufficiently long, the flesh may be frozen. Here we have a complete refrigerating machine, differing in no respect as to principle from the great factory plant turning out a hundred tons of ice per day, and one which is actually used in just this form for freezing small specimens for scientific purposes in laboratories.

But how is the "cold" produced? "Cold" is simply the absence of heat. All liquids tend to evaporate. If evaporation is sufficiently rapid, the liquid is said to boil. Different liquids boil at different temperatures; water at 212°, ether at 100°, etc. Moreover, the boiling point depends upon the pressure existing on the surface of the liquid. Thus, water requires a temperature of 308° to boil, when confined in a boiler under a pressure of 100 pounds of its own steam, but if it be subjected to a partial vacuum, say of 10 pounds, its boiling point is lowered to 193°. These two things then—the nature of the liquid and the existing pressure—determine its boiling temperature.

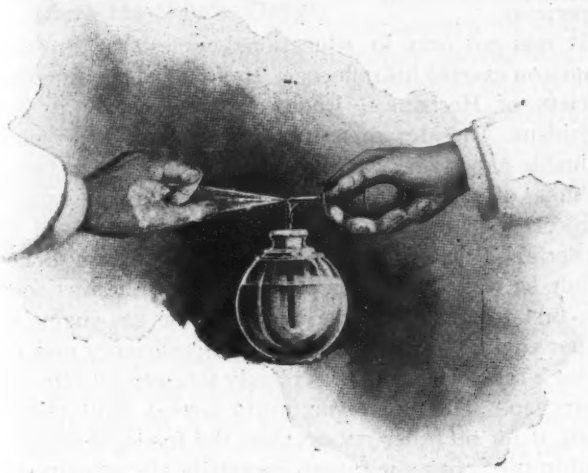
But again, how can "boiling" be made to "freeze?" Boiling requires heat, and this must be furnished from every available source. When no more heat is to be had, the liquid ceases to boil. Now the word "heat" must not be limited to the common understanding of a-sensibly-high-degree-of-heat, such as that produced by fire. Heat exists in all bodies, and the concentration of it is what we erroneously call "heat," meaning "temperature." Thus, cold water is "hot"; that is, it contains some heat, and "hot" water is strictly "hotter" water; that is, it contains more heat. In order then that our spray of ether may evaporate (boil), it must have heat, and this it takes from the nearest object, the flesh of the hand. The atomizer is therefore a complete refrigerating machine.

A still more available illustration may be had by dipping the hand in water and waving it in the air. The water evaporates and the hand is cooled. If alcohol be substituted for water, the hand will be cooled more rapidly, because the alcohol evaporates more quickly. Evaporation, then, is always a cooling process, and the application of this simple law is the foundation of the manufacture of artificial ice.

Obviously, in manufacturing, we wish to hasten the process as much as possible, and we therefore seek for a liquid having a low boiling point joined with a high "latent heat of vaporization" (carrying capacity for heat); non-corrosive and cheap. Such a liquid is anhydrous ammonia, the name for perfectly dry and pure ammonia gas compressed and cooled until it liquefies. (This must not be confounded with the ordinary ammonia of the druggist, which is simply a solution of ammonia gas in water and worthless for freezing purposes.) Anhydrous ammonia is shipped in heavy wrought-iron cylinders under pressures ordinarily of 120 to 150 pounds per square inch. Its boiling point at atmospheric pressure is 28½° below zero; that is to say, it will draw off heat till it produces that temperature when allowed to evaporate into the air.

Let us at this point clear up the singular notion, often encountered, that the freezing of ice by ammonia is somewhat a

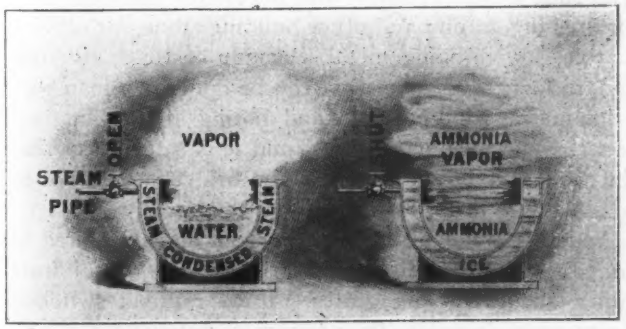
"chemical" process; as if the ammonia were stirred into the water and in some mysterious chemical way froze it. The idea is of course an absurdity. The ammonia acts purely by its physical properties and not as a chemical.



Hand-Power Refrigeration

Take as a familiar illustration a jacketed kettle, filled with water, and steam supplied to the jacket. The water boils away, and in doing so robs its supply of heat from the steam, which is thereby condensed into its original liquid form, so that if not drained off, the jacket will shortly fill with the condensed water. When so filled, the water in the kettle, not being very volatile, will cease to boil, having taken up all the surplus heat available from the steam; in other words, having cooled the steam down to its own temperature and reduced it to water.

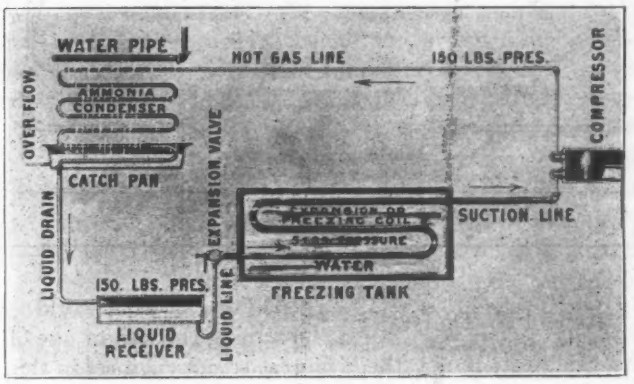
Next, the water having boiled away, let us refill the kettle with anhydrous ammonia. This liquid, being exceedingly volatile, will commence to boil violently and further rob the condensed water in the jacket of its remaining store of heat, until, when the ammonia is all boiled away, the jacket will be found a solid mass of ice. The complete process of ice-making is thus very clearly exemplified, and it is apparent that there is nothing chemical about it. In the second step the water



From Steam to Ice

in the jacket furnishes heat to boil off the ammonia, thereby becoming cooled to the freezing point, in precisely the same sense that the steam originally furnished heat to boil off the water, thereby becoming cooled to the liquefying point. There is no mingling of the two liquids, and no chemical process whatever.

We are now ready to understand the full mechanism of an ice plant. The apparatus commences with the liquid receiver, into which the ammonia is charged from the flask, the latter being returned to the manufacturer. The ammonia in this receiver being at a high temperature, at least that of the atmosphere, is under a pressure of say 150 pounds per square inch. A small "liquid line" leads from the bottom of the "receiver" to the "expansion coil," through the "expansion valve," which is a needle valve having a small taper orifice capable of close graduation. The ammonia trickles through this valve in a fine stream, and finding itself in the expansion coil and relieved of pressure, proceeds to boil away violently into ammonia gas. In doing this it takes the necessary heat from the coil, so that if we submerge the latter in a "freezing tank" filled with water, the ammonia will continue to boil until it has taken all the heat it can get from the surrounding water; that is to say, until the water has been cooled and finally frozen.



An Elementary Ice Plant

This would be a complete but impractical ice plant, for the expansion coil must not be open to the air, thereby wasting ammonia of greater value than the ice made, nor can it be closed lest it fill with gas under pressure and stop the process. In practice a powerful air pump, ordinarily termed a "compressor," sucks the gas from the expansion coil and compresses it into a liquid to be used again. It, however, does not turn into liquid in the compressor, but is forced as hot gas under high pressure into the condenser, where the film of cool water on the pipes performs the final act of chilling and recondensing it into liquid ammonia ready for a new round of service. Plainly this is not a chemical but a physical process; and, moreover, it occurs in a closed circuit, the ammonia being recovered and used over and over. Note also that the water itself has two distinct uses—for freezing into ice and for condensing the gas. The water for the ice must be of the purest character; that for the condenser may be of any quality, so long as it is abundant and cool. There is no mingling of the two.

The above apparatus and process are common to every form of ice-making or refrigerating plant working on the compression system, the differences being only those due to modified detail.

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Franklin R. Moore, Chairman **W. S. Wetzler**, Secretary
George W. Richardson
W. J. Eccles **C. W. Leng**

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Robert H. Thurston

The engineering world is mourning the loss of one of its brightest, if not the brightest steam engineer in this country, Professor Robert Henry Thurston. Professor Thurston by his life work has richly earned for himself the title of a great educator, a great writer, and a great engineer, and as such his memory will be long cherished not only by students and graduates of Cornell College, where he taught for many years, but by students and engineers all over the country. Professor Thurston was born in Providence, Rhode Island, in 1839, and was graduated from Brown University in that city twenty years later with degrees in philosophical and engineering studies. The next two years he spent in the noted shops of his father. In 1861, he entered the United States Navy as assistant engineer and as engineer in charge of vessels. At the close of the war, in 1865, he became an Assistant Professor at the Naval Academy, at Annapolis, where he founded the course of study then begun for the training of the engineering corp of the navy.

When the Stevens Institute of Technology was opened in 1871, Prof. Thurston became the first head of the School of Mechanical Engineering, and as head of that department, he remained until called to be Director of Sibley College of Cornell University, which position he held at the time of his death, which occurred on his sixty-fourth birthday, October 25, 1903. For forty years his life was spent in the training of engineers for the naval and commercial needs of his country, and he has left the imprint of his personality upon the many hundreds of young men who have gladly sat before him and availed themselves of his broad education and engineering experience.

It was not only in educational circles that Professor Thurston exerted his influence. He founded the American Society of Mechanical Engineers and became its first president. Besides presenting this society with many valuable papers, he was the author of more than twenty volumes of engineering books, treating of a wide range of subjects, and including such books as Materials of Engineering, Friction, Steam Engines and Steam Boilers. While he was distinctly a steam engineer, he was one of the first to appreciate the merits of the gas engine and vapor engines and the performances, efficiency and uses of each type of enigine, was plainly foreseen by him some years ago. The engineering world loses a most valuable man, if for no other reason than the foresight which he had in predicting the future, especially along engineering lines with which he was familiar.

Electricity Versus Compressed Air

It is interesting to watch the rivalry which exists between the advocates of electricity and the advocates of compressed air, for supremacy in the industrial field. As one writer expresses it, "the wires and pipes are fighting each other and the 'rooters' for the condensed atmosphere are jubilantly declaring that compressed air has scored the most points."

We are all well acquainted with the uses of electricity of to-day, as applied to the electric cars, electric light, electric telegraph and telephone, and its other varied applications, but perhaps we are not so familiar with the uses of compressed air.

Compressed air is used in almost every machine shop, foundry, stone-cutting establishment, railway shop, naval yard, quarry, mine, boilershop, and in almost any industrial shop in this country, and pneumatic tools are used for dressing granite and other building stone, for carving marble, for chipping metal, cleaning castings, riveting, and, in fact, everything that can be done by a man with a hammer. All kinds of hand boring and drilling are done by the pneumatic drills, and it is safe to say that the rapid erection of buildings and bridges would not be possible were it not for these tools.

And this is not all that compressed air is required to do. It paints buildings and bridges, digs metal from mines, shakes furnace grates, throws railroad switches, cleans grain, increases the pressure of natural gas, shoots mail and express packages from station to station underground, copies letters in office letter press, sinks bridge caissons, cleans rugs and carpets, runs street cars and locomotives, and drives the movable torpedo through the water on its mission of death and destruction.

These are a few things which compressed air is used for, and it will be well in the future to watch the development of this important industry, as well as its more spectacular rival, electricity.

Learn the Simple Things

We sometimes find among engineers a disposition to ignore the simple things of their craft, because they believe that they are fully versed in such things and could more profitably employ their spare time on something else. This may or may not be true according to the standard which they set up for themselves as a basis of comparison. But where we come to inquire into some of these apparently simple everyday matters, it is surprising how much there is in them which perhaps we had not discovered before. It is principally because of this indifference to small matters that men arrive at that age in which they discover how little they really know.

As a matter of course we can know but little of the great amount which is to be known, even after having devoted a lifetime of study and observation of our chosen vocation; therefore, we should all the more earnestly strive to learn and acquire those things which are within our reach. There is hardly a day passes in which there is not something of value to be learned from the usual and unusual happenings in the steam plant.

Future of Steam and Gas Engine

The relative efficiency of the very best type of steam and gas engine is about the same for both types of engine. Each has delivered a horse power with one pound of good coal, and these engines have both attained a maximum efficiency, between the coal pile and the point of delivery of about 20 per cent., so that at the present time neither type of engine can be said to be better than the other as regards the efficiency.

As to future, the steam engine seems to have attained very nearly its limit, and its efficiency seems to be dependent mainly upon the possibility of still further increasing the boiler pressure or by superheating the steam or by both. Higher pressures are coming to be available and in experimental work one thousand pounds pressure has been employed, without, it is said, any especial difficulty. Superheating of steam is now beginning to be done practically and there is little doubt that it will be used successfully in the course of time, notwithstanding its present objections. These improvements will permit the increase of possible efficiency to about 40 per cent., and would bring the consumption of coal down to about three-fourths of a pound per horse power per hour. This would seem to be about the best performance obtainable.

With the gas engine, there seems to be a larger opportunity to reduce the wastes which occur in all gas engines than the wastes which necessarily occur in the steam engine, and more development should be expected from the gas engine than from the steam engine. The gas engine has now come to be a formidable rival of the steam engine, and, if successsfully improved, it will no doubt displace the steam engine in many directions.

In some directions, as at sea, in the locomotive and some other uses, the steam engine will no doubt hold its place, but this is by no means certain, as the main object of any class of engine is to produce the most power with the least cost, and the engine that can do it most satisfactorily is the engine that will be used in the future.

Grease in Boilers

The importance of excluding grease from the water side of heating surfaces of a boiler cannot be too strongly commented upon. While it is well known that scale is very injurious to a boiler, it is, according to one writer, not nearly so injurious as grease. For instance, it is stated in a paper read before the Institute of Naval Architects in England, that, roughly speaking, a film of grease $\frac{1}{100}$ of an inch thick, a layer of scale $\frac{1}{10}$ of an inch thick and a steel boiler plate 10 inches thick, offer equal resistances to the passage of heat. That is, grease offers about one thousand times and scale about one hundred times the resistance to the transfer of heat as would a steel plate of equal thickness.

If this is so, it can easily be seen why a boiler will run uneconomically if its water surfaces are covered either with scale or with oil. To raise steam to a pressure of ninety pounds, the water must be heated to a temperature of about 320 degrees Fahrenheit. In a clean boiler this may be done by heating the external surface of the shell to about 325 degrees. If a one-half inch of scale intervenes between the shell and the water, such is its non-conducting power, that it will be necessary to heat the fire surface to about 725 degrees, almost red heat, to raise the temperature of the water 320 degrees.

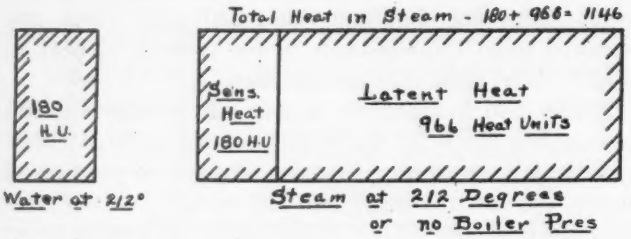
According to the same rule, if grease was present in the place of scale, the iron surfaces would be melted or nearly so, but grease is never present in such quantity. The effect of a small quantity, however, is shown by the fact that if only 0.02 of an inch was present with the other scale, its presence would cause the surface to heat up to about 1200 degrees Fahrenheit. The grease appears to mechanically combine with the scale and clings in a loose, spongy mass, to the boiler, too inert to be carried off by the circulation or ebullition, which it retards and so prevents contact between the plates and the water and causes overheating.

The higher the temperature of iron is kept, the more quickly it oxidizes, and at any heat above 625 degrees it very soon becomes brittle and is liable to bulge or crack or otherwise give way to the boiler pressure. It is this condition that is likely to cause explosions and makes necessary expensive repairs. Fortunately, the presence of grease in a boiler is not so prevelent as scale-forming ingredients, except in the case where condensing engines are used and where proper care is not taken to extract the oil.

Effect of Heat on Water and on Saturated Steam.

The effects of heat upon water and steam must be studied, if one is to obtain even an elementary knowledge of the action of steam in the steam engine cylinder. The changes in the physical properties of water and steam through the application of heat can be very accurately calculated, but most of the calculations are very complicated, and tables have been prepared, called tables of the properties of saturated steam, to make the work simpler and more rapid.

A fact, which is very plain, is that steam has weight just as water or any other substance. The fact that gaseous substances tend to rise is no indication that they are without weight, but it simply shows that these gaseous substances are lighter than air. If one pound of water is heated and converted into steam, there will be exactly one pound of steam, no more, no less; and this shows that the heat that has been added to the water has added nothing to the weight. Heat is not a substance and cannot be weighed. Its effect upon substances can be measured by noting that when heat is added to a substance, it causes that substance to expand or grow larger. The thermometer acts on this principal by expanding the mercury in its tube. When a thermometer is plunged into melting ice, it records a certain temperature, which is

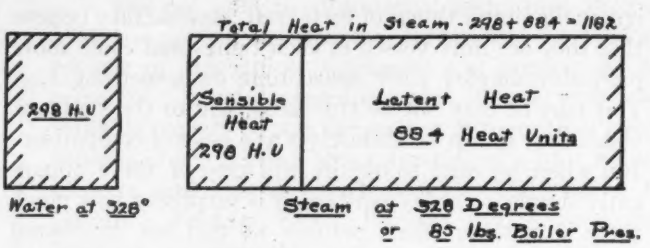


said to be 32 degrees, and when it is placed in steam at atmospheric pressure, the height of the mercury in the thermometer is said to register 212 degrees. There is, therefore, a difference of 180 degrees between the freezing point and boiling point of water, so that when one pound of water is raised one degree in temperature, a unit of heat is said to have been added to the water. This is always taken as a standard for all heat measurements. As it requires a slightly greater amount of heat to raise water one degree when it is cold, than when it is hot, one particular point on the scale of the thermometer is chosen for the determination of the heat unit. Water at 39 degrees is at its greatest density, that is, it makes no difference whether it is cooled or heated, the water will expand from a temperature of 39 degrees, and the heat required to raise water from 39 degrees to 40 degrees is taken as the standard heat unit called the British Thermal Unit, abbreviated B. T. U.

It is easy to recognize what the effects of heat are, but it is not so easy to tell exactly what heat is. In practical work we are concerned more with the effect and measurement of heat than the exact phenomenon itself, and the steam engineer is most concerned with its action upon steam or water.

Starting with a pound of water at the freezing point and supposing it to be gradually heated, it will first decrease in volume slightly for about seven degrees, or until the temperature has increased from 32 to 39 degrees. The water will then commence to expand, and just as the boiling point is reached it will occupy 4 per cent. more space than when it was 39 degrees and it required 180 heat units to raise it 180 degrees from freezing to boiling point.

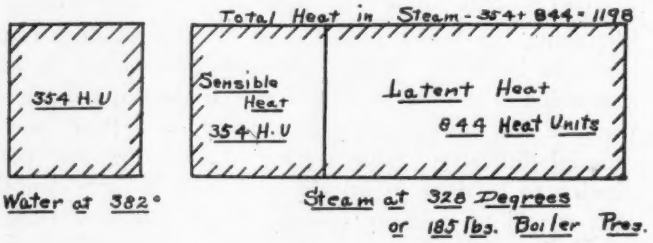
We now come to the next step in the study of the effect of heat. If the vessel in which the water is placed is open to the atmosphere, the water will begin to boil at 212 degrees and the temperture will not increase beyond this point, no matter how hard the water boils. When all the water has been



evaporated, it is found that the amount of heat, which was required to change that pound of water into steam, is equivalent to 966 heat units.

Because neither the water or the steam was raised above 212 degrees but these 966 heat units were used to evaporate the water, these 966 heat units are called the latent heat of saturated steam, because it produced no effect that can be measured by the thermometer, and the heat is, therefore, latent or dormant, as it were. This then divides the kind of heat to evaporate water into two classes; sensible heat, or that recorded by the thermometer, and latent heat, that which is not; and the total amount of heat required to raise a pound of water into steam is always the sensible heat plus the latent heat. For example: In the present case, it requires 180 heat units to raise a pound of water from 32 to 212 degrees and 966 heat units to change it from water at 212 degrees to steam at 212 degrees, so that the total heat required is 180 plus 966, which is equal to 1146 heat units, the total amount required.

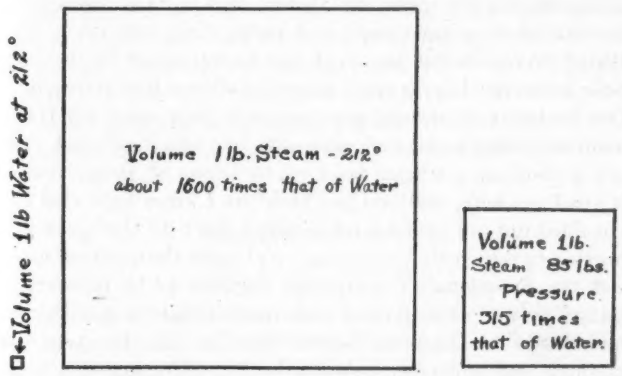
If the receptacle containing the pound of water were closed to the atmosphere, instead of being open, the conditions under which the steam would be generated would be different. At 212 degrees steam would commence to be evaporated as before, but as none of the steam could escape, the pressure would rise and increase rapidly. Suppose that the pressure increased until it reached a boiler pressure of 85 pounds. At



this pressure, the temperature of the steam, as found in the steam tables, is 328 degrees; the sensible heat required is 298 heat units, and this latent heat is found to be 884 heat units. Therefore, to raise one pound of water from 32 degrees to steam at 85 pounds pressure would require 298 plus 884=1182 heat units, or only 36 heat units more than is required to evaporate it at atmospheric pressure. Take a high boiler pressure, as 185 pounds per square inch. The temperature at this pressure is found to be 382 degrees, its sensible heat above 32

degrees is 354 heat units and its latent heat 844, or a total of 1198 heat units, which is only 16 heat units more than is required to raise steam to 85 pounds boiler pressure and 52 heat units more than required to evaporate it at atmospheric pressure.

Without going into the discussion of the subject, it can be seen that one economy of heat in a steam plant is obtained by using high steam pressures, provided, of course, that it is economically used in the steam engine; as with only a small amount of additional heat, there is a large increase in pressure. While water under pressure is practically incompressible, steam is very easily compressed in volume, and, therefore, one pound of steam at atmospheric pressure has a very much greater volume than steam at 85 pounds or 185 pounds pressure, which we have taken for our examples. For example, if we take a pound of water at 212 degrees and heat it unti it becomes steam, the steam will occupy 1600 times more space than the water from which it was evaporated, but if the steam and water were confined in a tank of such capacity then, when all the water was evaporated, the pressure gauge



would show 85 pounds per square inch, the steam would then occupy a space which would be 315 times that of the original volume of water, and this is about one-fifth the volume of steam at atmospheric pressure, that is, the steam has been compressed to this volume.

Wind-Driven Electric Plants

A lecture on this subject was recently delivered by Prof. P. la Tour before the Copenhagen Technical Congress. On behalf of the Danish government, Prof. P. la Tour has for many years been engaged in experiments on the use of wind-motors in connection with the operation of electric generating plants, the results being fairly satisfactory. The main drawback has been the difficulty in obtaining approximately constant speeds, irrespective of the strength of the wind. It is reported that this difficulty has been overcome by the use of an intermediate shaft placed on a sort of balance; the transmission belt from the windmill leading horizontally down to the pulley of this shaft, and the pressure of the belt against it being regulated by means of the balance provided with convenient counter-weights. From the intermediate shaft another belt leads to the dynamo, it being found practicable by this arrangement to make the transmission belt from the mill slip on the pulley as soon as the load exceeds a given value, enabling the mill to run at any speed without carrying the speed of the dynamo above a certain limit. By means of this arrangement in connection with a maximum and minimum interrupter, inserting the machine automatically as soon as conditions are favorable, and switching it off again as the wind becomes too weak, the author claims to have obtained excellent results, the plant having proven satisfactory even during the strongest storms. As a matter of course, storage batteries are always used in connection with such plants. A small station equipped according to this plan is said to have been in operation at Askoo, Denmark, ever since October, 1902, about 450 incandescent lamps being lighted with excellent results; a petroleum motors is provided as a reserve in case of several day's calm weather.

Inspectors to Wear Smoked Glasses

The inspectors of Philadelphia will soon go around with dark glasses looking at each and every column of smoke that rises in the city's sacred atmosphere, if the ordinance which passes the sub-committee of Councils becomes a law. The ordinance is to be enforced by the Bureau of Boiler Inspection, which is to ascertain when manufacturers disregard the provisions of the ordinance by means of a "color scale" and is designed to do away with the soft coal nuisance, and is supposed to effectively prevent the escape of noxious fumes within the city limits.

The city of Philadelphia, before the coal strike, of last year, was particularly free from the so-called soft coal nuisance, but at that time, hard coal being scarce and expensive, many manufacturers fitted their boilers so that soft coal could be used, and have still continued to use it. The city councilmen, however, finding that their new white collars were being soiled by soot every time they came to attend the meetings of councils, determined not to increase their laundry bills, and instead of changing their collars, they intend to make the manufacturers change their methods, or use hard coal.

The adoption of the bill as drafted has been opposed by manufacturers generally, who complained that it would be a hardship that few could stand and have threatened in the event of its passage, to move outside the city limits. Disregarding these protests, however, the following ordinance was passed by the commitee:

To regulate the emission of smoke from chimneys, stacks, or open spaces within the city; providing a color scale for the measurement of the degree and darkness of such smoke; making it unlawful to permit the escape of smoke of certain degrees of darkness and providing a penalty for the violation of this ordinance.

Section 1.—That for the purpose of regulating the emission of smoke from chimneys, stacks, flues or open spaces, within the said city, and to determine by comparison the degree of darkness of smoke so emitted, a color scale shall be, and the same is hereby adopted, as follows: One thickness of glass of sufficient capacity to cut off 60 per cent. of the light of a flame having a lighting power of sixteen candles shall be known and designated as No. 1 scale; two thicknesses of said glass shall be known and designated as No. 2 scale; three thicknesses of said glass shall be known and designated as No. 3 scale.

Sec. 2.—It shall be unlawful, and it is hereby forbidden to suffer or permit the emission or escape of smoke from any chimney, stack, flue or open space within the said city in the starting of any fires or fire between the hours of five o'clock A. M. and seven A. M., having a color exceeding in darkness

of No. 3 scale; or to permit the emission or escape of smoke as aforesaid, at any time from any fire banked or in a state of rest or from any burning fire, from any open space, from any stack or flue, under fifty feet high, in excess of No. 1 color scale of darkness.

SEC. 3.—It is forbidden and hereby declared to be unlawful to suffer or to permit the emission or escape of smoke from any burning or active fire, or through a stack, flue or chimney fifty feet or more in height in excess of No. 2 color scale for darkness.

SEC. 4.—It is hereby further ordained that smoke may be suffered or permitted to escape from any puddling forge, open hearth or other furnace now erected and existing for half an hour at the end of each heat, of a degree of darkness not exceeding No. 3 color scale, and from any puddling forge, open hearth or other furnace hereafter erected or a degree of darkness not exceeding No. 2 color scale, but that the emission or escape of smoke of a color degree of darkness or for longer time than that provided respectively in this section, is hereby prohibited and made unlawful, excepting brickyards located 1500 or more feet from any street occupied by dwellings.

SEC. 5.—Any person or persons who shall violate any of the provisions of this ordinance, or suffer or permit any of the acts hereby forbidden or declared to be unlawful, shall be subjected to a penalty of $50.00 for each offense, such penalty to be collected and recovered as debts of like amount are now by law recoverable.

SEC. 6.—The provisions of this ordinance shall become operative and effective on the first day of June, 1904, and the enforcement of said provisions shall be and is hereby made the duty of the Bureau of Boiler Inspection, subject to such incidental rules and regulations as the said Bureau of Boiler Inspection may establish and provide. Provided that this ordinance does not apply to private dwellings.

A Recent Kansas City Installation

The Leose-Wiles Cracker and Candy Company, of Kansas City, Mo., has recently completed the construction of a new factory, located at Eighth, Santa Fe and Heming Streets, Kansas City. The new building, which is of modern mill contruction, is 184 feet long by 128 feet in width, and consists of six stories and basement.

The power equipment of this factory embraces one 75 kilowatt and one 100 kilowatt Westinghouse generators connected to Straight Line high speed engines. There are also a number of Westinghouse motors in use in this establishment. The current, which is supplied to these motors at 110 volts, is conveyed from the switchboard by means of rubber-covered cables. The power is economically distributed, a separate motor being provided for each department. All motors are suspended from the ceiling and are connected to the machinery by belts.

The switchboard apparatus was also supplied by the Westinghouse Company. The connections between switchboard and generators are such as to allow the operation of either generator for power or light exclusively; or both generators may be used for light and power at the same time.

The boiler plant consists of six P. Delaney & Company tubular boilers, each 60 inches in diameter by 16 feet long. These boilers are equipped with Roney Mechanical Stokers.

All of the apparatus in this plant was installed by the Reed-Squires Electric Company, of Kansas City.

Noon Hour at Powers' Mill

Part V.

By A. EDWARD RHODES.

Hellow Hans how is this? I thought you were fired. So I vas Shames so I vas, bud dot furrener veller vot vos hired hisseluf to Mister Bowers und sed he vos some chief engineers mit a stheam boad, un dot he vos a licencensed blummer, he vos nod so schmart as he dinks he vos, nit. Listen und I dells you all aboud it, it vos like dis. Dennis he dells me dot he vos so madt dot I vos fired dot he makes up some shobs mid der new man, like dis. You know dot Dennis is a great fireman Union man und he says to der new man vot had my shob, Pietro you better vos know dot if you ain't got a schrew loose somevere you must connect mit der steam makers union at vonce, or id vill get plamed hot for you mit der boiler room. At dot Dennis says, der Frenchman says, I onerstand, und off he goes und crawles around all der steam bibes in der boiler room mit a bipe wrench, und vile he vas occubied in crawlin, in valks Mister Bowers himself und he asks, vot in der vorld vos you doin mit dose bibes? Und der new veller he says dot he vos huntin der union vot Dennis says he must connect or der vill some steam escape und make dings hot vor a vile. Mister Bowers did'nt say much but he oxblained dot it vos a labor union dot Dennis ment und not a stheam bibe connection. Den he hunts ub der olt man unt says Dick sendt for Han's und led him haf his olt shob back agin, und leed der Frenchmans get a shob mit a stheam boad vot he knows all aboud, und so it vos I am here, und you bed your life I know how a oil can vos filled mit out spillin a drop, und I don't do him again in a hurry, ven somebody vos lookin. Naturally the question arose, was the Frenchman a competent engineer as he represented himself to be? The general consensus of opinion was that he understood his business better than he did the American methods and language, and that he was unfortunate in being in a strange country. To me it seemed, also, that he was unfortunate in getting among a set of men that were bound together by ties of years of service. Men that never saw a sign like one on the wall in a ball room out west, which read: "Don't shoot the fiddler, he is doing the best he can." Engineers let us give the new man a helping hand, who knows but what he may be able to return the favor some day, even if he can't, most of us can look back and we still feel bad when we think of the especial trials and worries incidental to our taking hold of a new job. * * * * * * * * * *

Who works the hardest? The competent, or only fair to good engineer? Looking over the employees of any industry, one sees the competent men leading a comparitively easy life, taking hold of any job on a moment's notice, going at it in a methodical, systematic, practical manner, with a familiar touch and an easy swing and achieving results beyond the pale of unfavorable criticism. There is no haste, no waste, with their accompanying disturbances, no need of the chief engineer standing over them and directing every move, in fact, practically doing the job himself after all, while the incompetent man with the same conditions perspires, swears, aks fool questions, takes more time to do the same job and makes a botch of it after monkeying around in a half-hearted, disgusted, I don't-give-a—care-if-it-works-or-not way. Sometimes it happens that one of the non-comp's is put in charge of a plant, then is where the engineers troubles begin. Old Dick was telling us of a case where he once worked. It seems that they

wanted to install a plant involving about sixty incandescent lamps, necessary wires, switches, switchboard, dynamo, shafting, etc. The Boss figured the speeds of the several pulleys, then said he would run the counter-shaft at 650 revolutions per minute. Dick succeeded in pursuading him to cut the speed down to 450 rev. A gas engine being the prime mover, it was decided to put two small fly-wheels on the counter-shaft to help counteract any irregularities in speed due to using a gas engine to furnish the power. These wheels were taken from a small engine and weighed about 300 lbs. each, and counterweighted, as many engine wheels are, but no attention was paid to a little thing like that. The result may readily be imagined. Fortunately no one was hurt in the discovery of the action of centrifugal force. The wheels were not broken, so the apparently weak places were patched up, and the wheels made to go around again, but slower this time, result: still a lot of wobble.

Dick says that now the Boss was not so bossy but ready to listen to common sense, and the cause of the trouble was found. The wheels were balanced, the boxes fitted up, and lined true and level, the machines properly fastened, belts laced just tight enough to pull their load and since then they have been running as machines should run. But what a botch job, what a lot of trouble and hard work for men that were helpless in the matter. Had a competent mechanic taken hold of the job at first, it would have been done right at once for all, in less than one-fourth the time, worry, expense, and no shame-faced excuses to offer and no contempt from the men under the Boss.

Emergency Repairs.

By C. W. Dunlap

A loud knock on the front door awakened me, and in a very few minutes I was reading a message, that was something like this: "Our stack struck by lightning and destroyed, building also damaged, especially the boiler room, send new stack and man to put things in shape, etc." Now it was two o'clock in the morning when I read the telegram, and the note that accompanied it from my foreman of the machine shop where I was then employed. The foreman's note stated that I could get an accommodation train to the point where the trouble was, at 3.30 A. M., and to be sure and be there.

Well, after the usual growl that accompanies being dragged out of bed at such a time, and a hurried gathering of tools, I got to the station, met the foreman, and was instructed to get the mill in shape just as soon as I possibly could, and the foreman told me that he would ship the stack on the first freight in the morning. Well, after the usual instructions from the foreman, I took the train and in due time was on the scene of the troubles.

Well, when I jumped from the buggy that brought me from the depot to the saw mill, I thought that it would take a week to make any repairs at all, but on closer examination, I came to the conclusion that if I could only get the new stack there that day, I would be ready before night. I met the superintendent in charge and he told me just how they were situated. They had a large contract to finish, which would take every hour of their time to get it out according to agreement, and as the Fall was well along, it was liable to snow any time and shut up the roads, and the company would then loose a large sum.

I found the stack had been struck by lightning, and as completely demolished as if it had been flattened through a pair of rolls. The gauge cocks were broken, gauge glass gone, and the steam-gauge was fit for a junk shop, the only thing remaining intact on the boiler in the way of fittings was the safety-valve (lever type), which had not been harmed in any way. There was no steam on the boiler nor no fire under it, so I searched around and got two ½" globe-valves and screwed them into the water-column, put a plug in where the third or top gauge-cock was. I shut the ¼" valve that connected from the coil to the steam-guage, cutting out the steam-guage entirely; might as well, for the gauge was demolished. I inquired as to how much steam had been carried on the boiler, and the superintendent told me about 100 lbs. per square inch, as per gauge. The next move was to arrange to carry this pressure without the gauge. In order to do so, I took the ball off of the safety-valve lever, weighed it, got the length of lever, weight and diameter of valve, and stem length of fulcrum. I then proceeded to calculate the distance the ball should be placed on the stem to blow at 100 lbs. per square inch, and found that I had to move it toward the valve ½" from where it had been before the accident. This far, all right. I examined pump, piping, injector, and everything about the place, filled the boiler with water through the safety-valve, and when the water showed in the second valve (temporary gauge cock), the boiler was all ready except the stack. Well, at dinner time, I was informed that there was a wreck on the road, and that likely they might not send out a local freight that day. On my return to the mill, I informed the superintendent that I thought we would have to rig up a temporary stack, and he wanted to know, of what? So I told him to take some of the heavy planking he had then and make a stack. After some parleying, I got him to make a box 16 feet long by 26" square, which I had lined with some heavy asbestos mill board that had been sent there for weather strips and pipe covering. The next move was to get the (stack?) in place. After getting two hickory saplings for shear-poles, we got the (stack?) around near the smoke box and raised it up allowing it to rest on the smoke box. Putting several pieces of asbestos mill board between the ends of planks and the smoke box, this crudely provised stack would not take off the gases from the boiler furnace fast enough, so I arranged a blower in it which worked fairly well. At any rate, the lumber was sawed out in the specified time, and we only had to use the temporary stack two days, until we got the steel one. I found on careful examination, when the new steam-gauge was put on the boiler, that my calculation of the weight on lever was about $\frac{1}{16}$" too far out on the lever to allow to blow at 100 lbs., the fault being caused by not getting accurate weights on the valve and stem, and the lever and ball. The scales I used to weigh them being out just enough to make the difference.

For this impromptu repair job I received a nice sum and a fine silver watch. I also got all the repair work from this company for the shop I worked in, and it footed them a nice tidy sum every year.

To Polish Brass.

When the brass is made smooth with a very fine file, it may be rubbed with a smooth fine grain stone, or with charcoal and water. When it is quite smooth and free from scratches, it may be polished with rotten stone and oil, alcohol, or spirits of turpentine.

LETTERS FROM ENGINEERS

IN ORDER to make this department of THE PRACTICAL ENGINEER as interesting as possible, a moderate rate will be paid by us for all contributions published under this heading. However, we do not assume responsibility for the ideas or opinions expressed. None need hesitate to contribute because of inability to draw or write well. We will redraw or revise whenever necessary—it is the idea we want. New ways of doing old things, criticisms of accepted theories, and general engine-room experiences are especially solicited.

The Condenser Problem

Editor PRACTICAL ENGINEER:

The question propounded by Mr. Switzer in your last issue is very interesting, and I have thought over it considerably. It is eminently practical, too, since it deals with a matter whose benefit is to be reckoned in dollars and cents. There is one thing which Mr. Switzer did not mention in his article, which I believe is the turning-point on which the answer hinges. He neglects to state the type of condenser which he uses. From the sketch, both steam and water mains lead into the condenser shell, and there is but one outlet, so that one would be inclined to the belief that it is a jet condenser. However, there is no statement to corroborate this, and so I shall give my impressions of the feasibility of the arrangement for each case.

First, suppose that it is a surface condenser. Then, since the condensing water and the exhaust steam do not mix, it will be necessary to use the vacuum pump or air pump, as before, to remove the water of condensation, and to maintain the vacuum. The only saving in this case would be that it would not be necessary to pump the condensing water. For there is no doubt that he could easily obtain a continuous flow of condensing water by the siphon arrangement he illustrates, so long as the free fall from the top of the condenser to the wheel pit is 34 feet or more, and the distance from the level of the supply to the condenser inlet is not over 20 feet. If the condenser is a jet condenser, there can be no doubt of its working and maintaining a good vacuum. For then it becomes simply an ejector condenser as used in many plants. It may be that the flow of condensing water will not be established simply by opening the starting valve. However, a small priming pipe led from the boiler feed pump will insure proper starting. There will be no danger whatever to the engine by the arrangement shown, since there is no way for water to get into the cylinder, and the slightest condensation in the exhaust pipe can be removed through the drip pipe provided. I believe that Mr. Switzer will find it to his advantage to use the ejector condenser arrangement. It will need only the piping shown in his illustration. If he uses a surface condenser, it will not work unless he employs the air pump, as before.

X. N. TRICK.

Priming Boilers

The Editor PRACTICAL ENGINEER:

The following are my ideas regarding the common phenomena of boiler priming, and the action of many boilers lead me to believe they are correct. Steam, in a boiler at rest, exerts its pressure equally in all directions, but when it is in motion, as in a pipe leading from it, there is a difference in pressure depending on the velocity of the steam in the pipe and its diameter. It is this difference of pressure which causes the velocity. If the pressure in the boiler is one hundred and twenty pounds, and the steam escapes in the pipe with such a velocity that its pressure is only one hundred pounds, there is a difference of pressure of twenty pounds per square inch. If the area of the pipe is three square inches, the total difference of pressure will be sixty pounds. There will then be sixty pounds more pressure on one side than on the other, and this difference is nearly equal to the weight of a cubic foot of water, so that the water in the boiler will rise enough under the exit pipe, and fall enough in other parts, to displace nearly one foot of water. No matter what the size of the boiler, so long as the total difference of pressure is only about sixty pounds, only one cubic foot of water will be displaced, so that in a small boiler the disturbance in the water surface may be considerable, while in a large one it may hardly be perceptible. It is apparent then that this would affect the height of the water in the boiler, as shown in the gauge glass, and this, too, is affected by the position of the exit pipe. If it is at one side of the boiler, the opposite side will have a water line too low, and the other side of the pipe one too high, so that a glass placed between those two sides would be the one to indicate the true water level.

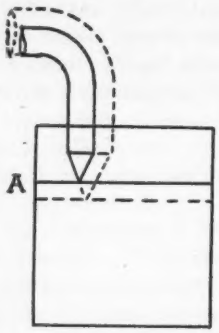


Fig. 1

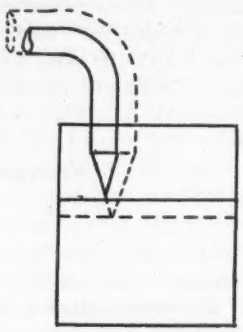


Fig. 2.

If the exit of the pipe ran out the centre of the boiler, any glass placed around its exterior will read too low, for the water would be a conical shape, with its apex under the pipe, and the base would be adjacent to the shell of the boiler. If, now, the exit pipe reaches down into the boiler far enough, or what is more probable, if the water level approached close enough to the mouth of the pipe, this upward displacement of the water may be sufficient to cause it to reach the level of the pipe, and then some of it would pass away with the steam. The height of the water under the pipe above the normal water level, depends on the difference in pressure in the boiler and the pipe, and also upon the size of the pipe. Let us suppose a case as shown in figure 1, in which the water is at A, that shown by the heavy lines. Now if the difference in pressure existing between the interior and exterior remain constant, and the water level at A is such that it is sufficiently close to the exit pipe to just cause the priming, then will a larger pipe have the effect of lowering the water level, at which priming will occur. If, as in figure 1, lines are drawn from the edge of the pipe to a point on the water surface directly underneath, then they form what I call for a better name "lines" of acting, and for the same difference of pressure these lines of action make equal action with the perpendicular from the water surface. It is therefore seen that the line of action from a larger pipe reach

further down than from a smaller one, and the depth at which priming will occur is consequently greater. Increasing the difference in pressure, has the effect of making these lines more perpendicular, and hence increase the depth at which water will be disturbed, as in figure 2. I have experimented with a bottle, by suddenly opening to the air a passage through the stopper, and find that the above is verified, as well as could be by this necessarily crude experiment. I have also noticed in operating a safety valve and boiler, that where it was slightly opened (corresponding to a small pipe) no moisture appeared with the steam. When it reached a certain open position (corresponding to a larger pipe) water came out freely with the steam. This seems to prove that the large pipe is more liable to produce priming, than a small one, other things being equal. Different steam pressure also seems to produce results which verify what has been said before.

Ledbetler, Texas. R. F. C.

Rodney's Troubles

or Do We Need a License Law in Michigan

(Second Letter.)

Mistur editur yestedy fathur cum hoam frum the stait fare and he brung a hul lot uv nu fangeld things with him, 1 thing wus a big wudden hammer fur a karpintur tu uze, now jist az i think ov the hammer, and 'bout the watter hammer i rit tu u about in mi last leter, the moar i think ov it the moar i think i wuz rong when i sed thet mi injine did'nt hav no watter hammer, fur jist yesteday as i was gitten dun, at the brownses on gilvens rode neer the meyander u no whear it is mr. editur, fur thays a big pound swete appel tre jist on the turn ov the rode thet leeds tu tuckers corners, every boy in the kuntry hez ett them appels.

well az i wuz saen mi reezons fur thinken that mi injine has that peski watter hammer iz, u no mr. editur thet mi injine haz a pump on it tu pump the watter in tu the biler with, well every time the big wheel gose around the watter or sumthin in whear the watter iz keaps a poundin and klikken, and poundin, now mebby u kud tel me if it iz the watter hammer or not. my bruther henry sez thet u no lots about sech things fur u liv in a big sitty whear thear iz a hoze kumpiny, and u must cee sum watter usd if the firemen dril, or when thear iz a barn birns, or a hay stak kechs fire by thunder and litnen, now if u can rite tu me about the watter hammer pleese du sow at wonct fur i am a feard thet the watter hanmerin mite du sum damidge to mi macheenry. donte fale tu rite jist as sure as you git this lettar fur as my father sez, a stich in tim savs ate or nine i furgit which, any how sumthin lik thet, in a fu dase i wil rite u about the cushen on mi injine, now surly donte fugit too rite, derekt ure leter tu

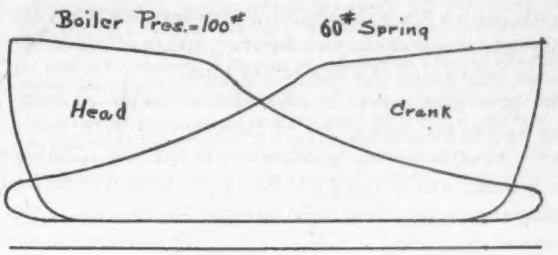
Rodney Gumkirk,
orkners korners
Munrow kountee
Mishegan

in kare mi fathur.

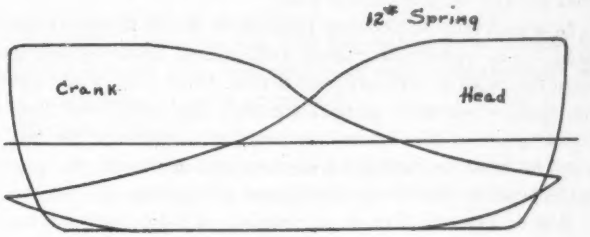
Indicator Cards

Editor PRACTICAL ENGINEER:

I enclose two indicator diagrams, which will interest some of your readers, that I have taken from a cross compound Corliss engine 24" and 46" x 48"; boiler pressure 100 lb.; revolutions 72 per minute; vacuum 25 inches. I would like to hear from some of your readers in regard to them. What I



want to find out is, why should the steam pressure drop on the steam line, because as far as I know there is no wire drawing,



and is the low pressure as near perfect as can be, and if not, what can be done to make it so? What causes it to come to a sharp point at the release?

Kenosha, Wis. C. W. B. McC.

Does Cold Air Hurt Boilers?

Editor PRACTICAL ENGINEER:

As I have been looking through the many mechanical papers, I find that one engineer still holds to the idea that cold air don't hurt the boilers while the sheets are hot and will cause them to leak. He thinks that if the flues are going to leak they will leak anyhow, and thinks they cannot always be seen, as the head of the furnace evaporates the water as fast as it leaks, and it only throws up at times. His idea is that the water in the boiler keeps the flues and sheets at about the same temperature, as the water and the temperature of the fire is many thousand degrees hotter than the iron in the sheets and the flues, and if you let cold air in the furnace, you only cool the fire down a little. It is still hotter than iron and if the air which strikes the boiler is colder than the iron, it is not any colder than it had been hotter. He don't believe it will do the boiler any harm. Now my idea is that cold air will do the boiler harm, and if the fire does evaporate the water, it will leave a mark on the boiler where it has been leaking. If a man would look after his boilers as he should, he will know when they are leaking. Where I have been employed for some time, they burn shavings under three of the boilers. They used to blow them under the boilers right from the planing mill. There were times they did not get any shavings at all, and it was cold air passing under the boilers and the tubes were

all the time leaking and we had to have them rolled at least once a month. The blower pipes were then taken out about three years ago and the shavings have since been fired by hand. The fireman will open the door and throw in about twelve shovels, with a No. 12 scoop, at a time for each door, the door being open about one to two minutes, and in all this time there has not been a sign of a leak of any kind.

We have nine boilers in all, which are in use 10 hours each day, 6 days per week. Six of these boilers burn coal all the time. At night it is the practice to run but five. This evening No. 7 boiler was to run while No. 8 and 9 were to be let down during the night. The night fireman on his way to shut the valves of No. 8 and 9 walked across the combustion chamber of No. 7 and the brick work gave way, causing a narrow escape for him. We had to shut the boiler down immediately, and the following day when the masons started to work we discovered the tubes were all leaking. We then sent for a boiler maker to do the necessary repairs. He claimed it was the cold air that caused them to leak.

Now he claimed that the tubes were much thinner than the head. The tubes contracted and caused them to pull away from the head. Now my idea is this: there is no water against the flues when they project through the head, and that the temperature of the water has nothing to do with the cold air and the water is not the same temperature at all parts of the boiler, unless there is an extra good circulation.

Where I used to work as fireman, we were not allowed to let the safety valve blow, and in order to prevent this, the chief gave orders to open the top doors of the furnace, allowing a rush of cold air over the fire and under the boilers to the combustion chamber, causing the tubes to leak at the rear head after a time. The practice of opening the doors was stopped and there was no more trouble with leaking flues afterward. My theory is this, if a boiler is as hot as it should be, then cold air will do it harm. I would like to hear from some of your readers what they have to say in regard to the matter.

Kenosha, Wis. C. W. B. McC.

Repairs to an Air Compressor of Faulty Design

Editor THE PRACTICAL ENGINEER:

Where I am employed there are two large air tanks 11′ x 18′, charged with air from two compressors 12″ x 12″, steam end, 8″ x 12″ air end. Now sufficient air can be compressed into each tank in one hour to last for about twenty-four, only one compressor is used to charge both tanks at a time, the extra compressor being for emergency. Considerable trouble has been experienced from time to time by the breaking of the cross head key, or cotter-pin rather. The piston rod is attached to the cross head in the following manner: A tapering hole in the cross head receives a like tapering piston rod. Through the cross head at right angles to the piston rod and through the piston rod is another tapering hole, with a (machine steel) pin in it $\frac{5}{8}$″ x $\frac{3}{8}$″ by 4″ long, a snug fit. Now the piston is threaded back from the end of the taper $1\frac{1}{2}$″ with a special (fine) thread, 12 per inch, and a nut $1\frac{1}{8}$″ diameter is fitted to it. This nut draws on the back of the cross head, pulling against (with shearing strain) this little $\frac{3}{4}$″ x $\frac{5}{8}$″ machine steel pin, which, of course, could not withstand any strain that so large a nut could offer, and if only just screwed up, say with 12″ monkey wrench, it would let go. Consequently there would be a break down and many harsh words for the manufacturer, etc. Now, for the remedy, I took out the cross head entirely, took it to the machine shop and had the small end of the taper hole for piston rod counter bored deep enough and large enough to admit of a $\frac{7}{8}$″ standard hex nut, and a socket wrench to tighten with, allowing the nut to screw up flush with face of cross head when up tight. I had the piston turned down sufficiently for threading for the $\frac{7}{8}$″ nut, making sure that there would be plenty for draught.

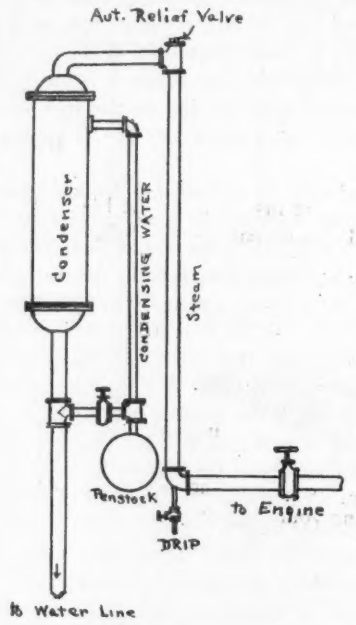
Previous to starting this job, the piston was properly trammed with the small taper pin in, so that there could be no mistake in length for piston travel, etc. The larger nut on the piston, I had cut in two, making a lock nut of one, thinking it would insure safety from loosening. I also put a hole in other end of piston and inserted split cotter to prevent the nut from coming off should it loosen at any time. This has proven a very substantial job.

ARXAKSAW WES.

Another Condenser

Editor THE PRACTICAL ENGINEER:

In reading the practical letters we often see some suggestions that just suits our case and in other things do not appear clear. On page 21, November issue of THE PRACTICAL ENGINEER, B. M. D. Switzer has made a sketch of his condenser and piping and wants to know if it will work. This reminds me of a home-made condenser that a young engineer made. He was running a small plant that furnished power for a laundry. He came to the conclusion that a condenser was needed, so he went to work to make one. His idea was to have the water enter the condenser above where the steam entered. The connections were made and all the parts appeared all right, so he started up his engine and all went well until shutting down time came and then the trouble began. The cylinder head was blown off and the piston rod sprung. To be sure he was not wanted any more in that little plant where his great invention took place. So in designing condensers of any kind, it requires good judgment and lots of hard thinking. In B. M. D. Switzer's



letter, it appears to me that this condenser resembles the one above mentioned, and if it was my case, I would have steam enter at the top instead of at the side. In this case, the water is in a direction downward, and as the steam is above it there is less danger of the engine taking water into the cylinder when steam is shut off. As to whether or not his condenser will work, I would say that it may, but will give poor satisfaction, and I would advise him to connect it as shown in this sketch.

Cambridge, Mass. W. A. D.

Poorly Constructed Boiler Settings

To the Editor of the PRACTICAL ENGINEER:

About a year ago I had occasion to visit a manufacturing plant in the Northwestern part of Pennsylvania. The parties were putting in a boiler of the horizontal tubular type of about 100 horse-power.

The boiler was placed in one corner of the building which, was made of brick, the walls of the building forming a part of the setting for the boiler on the back and right hand side; the back wall is a partition. Where the boiler stands it had been lately filled with cinders and refuse dirt and not much pains had been taken in filling it to make it solid.

I will attempt to give a description to show the defects in settings. The blow off will soon fill up and burn off, if the water contains many impurities. There is no way to get at it to clean it out except through a 12 x 18 inch door, which is about 12 inches from the floor, with space left back of bridge wall to fill up with ashes, etc. If the ashes were cleaned out, it would give you a chance to work at it, but it seems to me it would be much better if the blow off was protected from the fire.

The space between the wall and end of the boiler is so narrow that it would be impossible to work in case the boiler should need repairing unless a large hole was made in the wall.

I asked the superintendent why he did not put in an iron frame with two doors lined with fire brick, and he said he was looking after the insurance. The boiler settings should be so constructed that all parts of the boiler can be gotten at without much trouble. It is much easier to construct them properly at first than to have to tear a large portion of them down when the boiler maker comes to repair them. When the flues leak in a horizontal tubular boiler, it is generally at the back end, therefore it should be be so placed that it can be gotten at easily.

It is not so much setting the boiler up as cheaply as possible at the time but as cheaply as possible for the long run. Look out for the welfare of the man that comes after to repair it.

By setting your boiler properly at first you will save time and a great deal of trouble. "Time is Money."

Northeast, Pa. B. M.

Tunneling Artificial Rock.

In the construction of the extension lines of the Metropolitan Railway in Paris a curious engineering problem has presented itself. At the Place de l'Opera three lines of the railway will cross each other at three different levels. The presence of water in the sub-soil near the surface renders the construction of the tunnels somewhat difficult, and the engineers are solving the problem in a rather paradoxical manner. Large cavities are being dug in the earth and filled with great blocks of cement, forming a solid water-tight mass. Then the engineers will commence boring their tunnels through artificial rock sunk by themselves.

QUESTIONS and ANSWERS

THE editor will be glad to receive from the readers of THE PRACTICAL ENGINEER, such questions relating to engineering subjects, as may, from time to time, occur to them. All questions and answers should be addressed to the editor and accompanied by the name and address of the writer, which will not be published, however, unless especially desired. It is the intention that questions shall be answered by the readers, and even though the editor may, from time to time, publish answers and questions, he especially desires the readers in such cases to contribute any further information, in connection with the points raised, that they may consider of interest. All questions and answers received by the editor will be published, as far as practicable, but he reserves the right of editing or rejecting any communication.

Indicator Cards

Editor PRACTICAL ENGINEER:

Will you please answer through your paper the following questions:

(a) Which is the better way to feed shavings from a fan; in the front or side of a furnace?

(b) Would a fan be run with less power driven direct from a line shaft with a four foot pulley or with a countershaft using the two pulleys to make up speed?

Hanover, Ont. R. J. L.

(a) In another column will be found an article from an engineer, describing the bad effects of cold air in boilers, under the heading of "Does Cold Air Hurt Boilers," which will partly answer your question. The shavings should be blown in, so that the cold air should have a chance to get heated before striking the hot surfaces of the boiler, and whether this is in the front or side of the furnace depends upon the kind of boiler that is being used.

(b) The fan will be run with less power if run direct. If belted to a countershaft, there must be more power required, because the countershaft will absorb power and the extra belting will also absorb some little power.—[ED.]

Editor PRACTICAL ENGINEER:

1. Please give rules for figuring heating surfaces in radiators.

2. How many feet of heating surface will heat a room 12′ x 13′ and 9′ high, having 2 windows, 2 doors and double plaster walls, hot water radiators to be used.

Lacrosse, Wis. YOUNG FELLOW.

1. One of the handiest rules for finding the amount of heating surface in a dwelling where the ventilation is not a factor, is as follows:

Let C = number of cubic feet in the room.
" G = number of square feet of glass surface.
" W = number of square feet of wall surface exposed.
" H = number of heat units required.

then $H = \frac{1}{50} C + G + \frac{1}{4} W$

and the number of square feet of heating surface is obtained as follows:

$R = \frac{1}{4} H$ for steam heating,

and $R = \frac{3}{8} H$ for hot water heating, where R is the number of square feet required.

2. In this problem, the number of cubic feet in the room, is 12′ x 13′ x 9′, which equals 1404 cubic feet. Suppose two walls are exposed as 12′ x 9′ and 13′ x 9′, which equals 225

square feet, and the two windows are each 4′ x 6′, which equals 48 square feet of glass surface. This subtracted from the wall space in which the windows are, makes 177 square feet of wall space.

Using the formula, we have:

$H = \frac{1}{50} \times 1404 + 48 + \frac{1}{4} \times 177.$

$H = 27 + 48 + 44$ approximately.

$H = 119$ heat units.

Then R, the number of square feet of heating surface required is.

$R = \frac{2}{5} \times 119 = 48$ square feet approximately.

Therefore it will require 48 square feet of radiation surface to heat this room with hot water.—[Ed.]

Editor Practical Engineer:

I thank you very much for the answer to my question in November's Practical Engineer. My question was, that we had a tank 35 feet above the pump and I wanted to know if it would be lighter for the pump if we carried a pipe over the top of the tank instead of filling it from the bottom. Your answer was, that filling the tank from the bottom would be the better way. Now I thought when filling from the bottom and the tank being almost full, you have the weight of that water on the pump, but when the tank would be empty, it would be easier for the pump, and the more you get in the tank, the harder it would be, but filling the tank over the top, it would be one steady flow in the pipe. Kindly answer me through your paper if there is any way to figure that out.

Milwaukee, Wis. F. K.

The power that a pump exerts in lifting water depends upon two factors, the weight of the water pumped and the height to which it is pumped. In your question, the weight of water pumped being assumed constant, the height to which it is to be raised is the only consideration.

Let us assume that the bottom of the tank is 35 feet above the pump and that the tank is 10 feet high. If the tank be filled from the bottom, the head of water on the pump, when the tank is empty, is 35 feet, and when it is full, the head is 45 feet, and the mean head would be 37½ feet. If the tank be filled with the outlet of the pipe at the top of the tank, then all the water in the tank must have been raised to that level of 45 feet. That is, in the first case, all the water is lifted to a mean height of 37½ feet and the second case, all the water must be lifted to a height of 45 feet. As less work is therefore required in the former case, it is, as we have said in our previous answer, better to fill the tank from the bottom.

Editor Practical Engineer:

Please answer the following questions and oblige a constant reader.

(a) Does the lead change with the cut off on the Armington-Sims engine, where the Rites governor is used?

(b) What governors change the lead of the engine as the cut off changes?

Cambridge, Mass. A. W. W.

(a) In the Rites governor, the valve rod is attached to a pin on the weighted arm of the governor, which arm is suspended upon a stud to one of the arms of the fly-wheel. This makes the pin on the arm move in the arc of a circle about the stud, which varies both the eccentricity and angle of advance and therefore the lead changes with the cut off, the lead becoming greater as the cut off is shorter. Changing both the angle of advance and eccentricity tends, however, to make the lead constant with a varying cut off. The former Armington-Sims governor gave the valve a constant lead with a varying cut off, but instead of the pin which was connected to the valve rod moving in the arc of a circle, it was made to move in a straight line.

(b) All shaft governors, connected to a single valve, change the lead as the cut off is changed, except they fulfill the conditions above noted as the Armington & Sims and Erie governor. It is for this reason that many engines use more than one valve to overcome this difficulty.—[Ed.]

Editor Practical Engineer:

Will you please answer these questions for me? My engine is a 14 x 14 running 275 revolutions per minute. What should the length of stroke be; what would be the length of valve travel and what part of the stroke should cut off take place.

William Arvin.

1. The length of stroke of this engine is given by your figure 14 inches. In giving the dimensions of an engine the diameter of the cylinder is always given first and the length of stroke afterward, as a 10 x 24 engine means that it has a diameter of 10 inches and a stroke of 24 inches.

2. The travel of the valve is always twice the radius of eccentricity. This in automatic engines changes as the load changes.

The maximum travel of the valve may be obtained when there is no steam on the engine as follows: Turn the engine over by hand and scribe a line on the valve rod where it enters the stuffing box, when the rod has stopped moving in. Turn the engine by hand and watch the valve rod until it has stopped moving out and scribe another line on the rod as before. The distance between the two lines will indicate the valve travel. Its smallest travel is obtained when the engine is running without any load and can be found by noting the maximum distance traveled by some point on the valve rod.

3. In all engines, except those of the throttling type, the cut off changes as the load changes, so that it cannot be stated at what part of the stroke the cut off should take place. In order to give you a figure by means of which you can set your valve, it can be stated in the broadest terms, that with an engine running fully loaded of the type you mention, a cut off ¼ stroke is one usually adopted. Whether this or any other part of the stroke is the best point of cut off, is a matter of discussion and depends upon the steam pressure, type of engine, etc.—[Ed.]

Editor Practical Engineer:

Will you please tell, through the columns of your paper, what advantage there is in keeping water in the ash pit?

Chas. McLaughlin.

There are several reasons why water is introduced under the ash pit. When introduced underneath locomotive fire boxes and marine boilers of the locomotive type, it is usually done to prevent live coals dropping on wood work which may be beneath it. With stationary boilers, especially those that have rocking grates, water is introduced to prevent the rapid burning out of grate bars, which is often caused by the want of proper amount of air flowing through the grate bars, or by the spaces between the grate bars becoming obstructed, thus

preventing the cooling effect of the air on its passage to the fire. Another reason that water is placed in the ash pit is, that the hot coal in falling through the grate strikes the water in the pit and causes steam to rise. This steam in passing through fire is supposed to be decomposed and aid combustion.

As to whether the water in the ash pits is an advantage or not, the best authorities recommend that the ash pit should be kept dry and reasonably clean. As all the heat of the cinders and ashes is taken up by the air on its way to the grates, and that when steam is used, it requires just as much energy to disassociate the elements of the steam as is afterwards obtained by their combination with the coal.—[ED.]

Editor PRACTICAL ENGINEER:

Will you please answer the following questions through the medium of your valuable journal:

1. In making calculations with a lever safety valve, is it *necessary* to take into account the load on the valve due to the weight of valve stem and lever? There seems to be a difference between different authorities, and, as it is a very important problem, will you oblige by explaining with diagram and example?

2. How do you find the heating surface in heads of boilers?

3. In a Warren-Webster heating system, pressure gauge at zero and vacuum gauge showing 10 inches, does the pressure throughout the system exceed 5 lbs.? WM. SIDLEY.

1. The reason that authorities differ on this subject is because some do not think that it is of sufficient importance to calculate the weight of the valve and lever, but an exact calculation must take these quantities into consideration. The action of the lever safety valve can be analyzed as follows:

The steam pressure on the lower face of the valve, and therefore trying to unseat it, is so many pounds per square inch. We must find the area of the valve, and multiply it by the pressure per square inch, which will be the whole pressure upwards; but the weight of the valve acts downward and so destroys as many pounds of the pressure as its weight; the remaining pressure is the quantity to be counteracted, or the force that is trying to lift the lever and its weight. The following figure will explain:

F is the fulcrum; V is the point where the pressure is exerted; W is the weight. The principle of the lever is: The force or weight multiplied by its distance from the fulcrum is always equal to the weight on the valve multiplied by its distance from the fulcrum.

$$\text{Or. } W \times FW = V \times FV$$

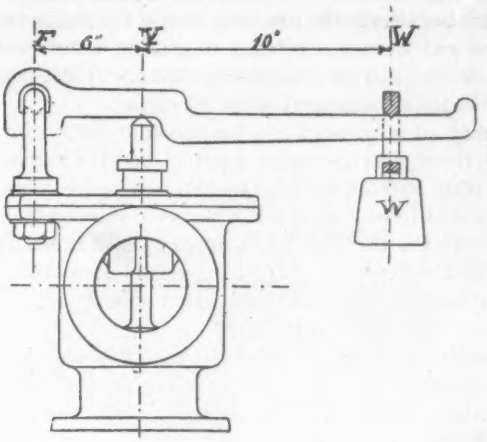
But the steam has also to overcome the moment of the lever, which moment is found by taking the lever off and weighing it, and also finding how far its balancing point is from the fulcrum F; then this distance multiplied by its weight is the effective moment of the lever, which we will call w.

$$\text{Then, } W \times FW + w = V \times FV.$$

That is, the total moment keeping the valve down is equal to the moment endeavoring to lift the valve off its seat.

Hence Rule (1.) Find the area of the valve and multiply it by the pressure per square inch.

Rule (2.) From the product take the weight of the valve; the remainder is the V of the formula.



Rule (3.) Multiply the remainder by "the distance from the fulcrum to the centre of the valve (FV), then subtract the moment of the lever, and divide by the distance from the fulcrum to the weight (FW)," found by adding "the distance from the fulcrum to the valve" to "the distance from the valve to the weight."

For example: Required the weight to be placed at the end of a safety valve lever to balance a pressure of 20 pounds per square inch, the diameter of the valve is 5 inches, the distance from fulcrum to valve is 6 inches, and the distance from valve to the weight is 10 inches. The effective moment of the lever is 80 inch pounds, and the weight of the valve is 12 pounds.

Area of Valve $= .7854 \times 25 = 19.63$ square inches.

Pressure on Valve $= 19.63 \times 20 = 392.7$ pounds.

Effective upward weight $= 392.7 - 12 = 380.7$ pounds.

Moment of lifting Lever $= 380.7 \times 6 = 2284.2$.

Effective moment of Lever acting downwards $= 80$ as given in problem.

Effective upward Lever $= 2284.2 - 80 = 2204.2$.

This is balanced by the distance of weight from fulcrum multiplied by the weight W,

$$\text{or, } 16\ W = 2204.2$$
$$W = \frac{2204.2}{16} = 137.7 \text{ pounds.}$$

That is, it will require a weight of 137.7 pounds at the distance given to balance the pressure on the valve.

2. In finding the heating surface in heads of boilers, there is no ways of exactly figuring it. The efficiency of the bottom of the boiler is taken at 100% and that at the top is considered to be zero, and as the sides hold an intermediate position between the top and bottom, the heating surface is usually figured as $\frac{1}{2}$ of the area of the end.

3. In a Warren-Webster system, working under the conditions you describe, the pressure would rarely reach 5 pounds pressure unless the air pump was not working properly, as there is seldom more than several pounds back pressure, when the system is working properly. It is the duty of the air pump to reduce it as small as possible. If, however, the system was full of ells and T's, the back pressure might be more than five pounds at some part of the system.—[ED.]

A New Manual for Engineers

A new book which has just been published is entitled "Care and Handling of Electric Plants," by Norman H. Schneider.

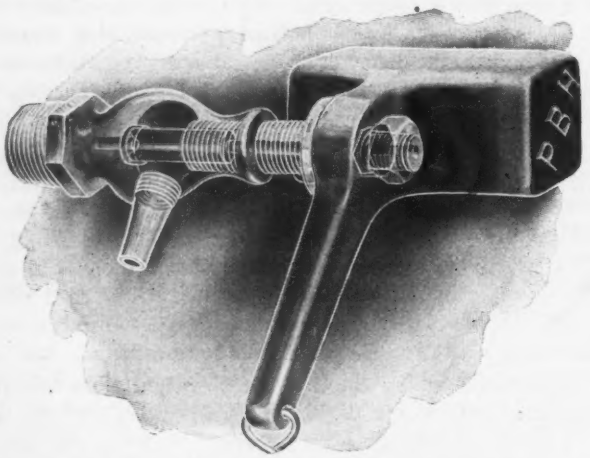
It describes clearly the practical uses of the electric current, dynomos and motors, electrical measuring instruments, the storage battery and the incandescent lamp. It also contains a chapter on the management of the oil engine.

This manual is intended as a handbook of practical information for those who are called upon to operate a commercial electric plant without having previous experience, while it will also be found to contain much of value to the engineer. It is written with the aid of notes actually obtained in handling the apparatus described, the chapter on incandescent lamps being specially notable, as this subject has not been given in other works the prominence it deserves.

It contains sixty-five original illustrations which have been drawn especially for the book. It is published by Spon & Chamberlain, 129 Liberty St., New York, and the publisher's price is $1.00.

A Quick Opening, Self-Closing Weighted Gauge Cock

The accompanying figure illustrates a quick opening and self-closing gauge cock, brought out by P. B. Huyette, 2025 Betz Building, Philadelphia, Pa., to meet the demands for

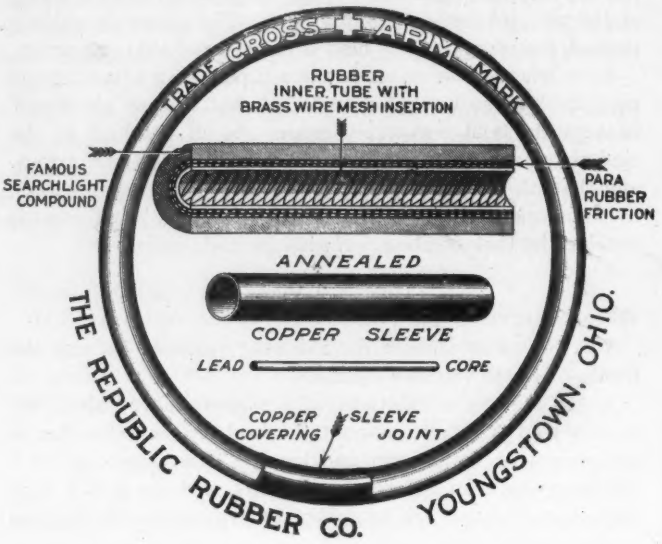


a simple, durable and inexpensive tri-cock. A specially prepared metal is used for the valve pencil which is one inch in length. One-half of this pencil is available for use, and when completely worn away, it can quickly be replaced by a new pencil at a trifling cost. Provision is made for ejecting the short piece remaining in the stem by means of a small hole ⅛" diameter in the stem.

It will be noted that this arrangement for utilizing the valve pencil for over one-half inches in length afford a cock which, for long periods, needs no repairing or attention, other than occasional adjustment of the weight at long intervals. The adjustment is made by unscrewing the nut and slightly raising the weight, which is then screwed in its new position by tightening the nut.

Cross-arm Gasket

The Republic Rubber Co., manufacturers of the "Searchlight" sheet packing, are also the makers of a gasket which possesses many unique and valuable properties. The accompanying illustration shows the composition and method of



manufacture of this gasket, which is made as follows:

A brass wire mesh insertion runs through the centre of the gasket adding to its resistance against high pressure. The rubber compound used in its make up is the same as Searchlight Sheet Packing, which neither hardens nor cracks under the most trying conditions of service or climate.

The method of wrapping the ends with tape is done away with. With the Cross Arm Gasket a copper sleeve is furnished to cover this joint. This sleeve is a special composition of annealed copper, which under heat and pressure vulcanizes solidly with the rubber, making the joint the strongest part of the gasket. This joint is perfectly smooth with the surface of the gasket, there being absolutely no uneven surface. Leaks and escaping steam are consequently avoided.

When the man-hole or hand-hole plate is screwed down, the gasket flattens to conform to any seat. The Cross Arm Gasket thus flattened becomes a thorough combination of rubber, wire insertion, lead and copper, offering the best possible resistance to the action of steam.

Lehigh Council

The gold badge offered by Lehigh Council, of Allentown, Pa., as a premium to the member presenting the greatest number of new applications during the last quarter, was won by Past Grand Chief, A. P. Dreisbach. The contest resulted as follows: A. P. Dreisbach, nine applicants; Wm. R. Smith, four; Daniel Heckman, two; Herman Roth, one; A. J. Straus, one; John Burley, one; Marance Eck, one; a total of nineteen and a number of others in view. There is no other city of 35,000 people that can boast of such a magnificent engineer's organization as this.

The recent prize drawing held by Lehigh resulted in the indicator being won by a young lady. The number of her ticket was 1110. Ticket number 630 drew the gold watch which was offered as second prize, but at last accounts the holder had not been found.

Philadelphia Council's First Ball

The first grand annual ball of Philadelphia Council No. 7 held at Junger Maennerchor Hall on Tuesday evening, Nov. 24th, was a delightful affair. The handsome large hall was crowded and every one thoroughly enjoyed themselves. Godfrey Knoos was grand conductor and was ably assisted by Harry Dunn. The grand march which artistically formed the letters "A. O. S. E." was a master stroke.

The prize waltz brought out the fancy dancers and the competition was spirited. The prize was awarded to Frank Redding of Jenkins Brothers.

The committee was composed of John J. Kelley, Clarence Muncey, Frank J. Cannon, W. J. Eccles, Peter Hardman, Sheppard Adams, Hugh McAleese, Geo. Howard, Edw. Whalen, Thos. F. Dougherty, Thos. Quinn, Odas Long. W. S. Wetzlter, J. L. High, C. Warrington, and Chas. M. Comer.

John J. Kelley was king of the occasion, and his excellent management was complimented by many of those present.

Prominent among the representatives of supply houses present were Logan, Le Count, McHugh, and Redding of Jenkins Brothers. L. E. Murphy and F. R. Moore of E. F. Houghton & Co., and Mr. Boemer, of the Trenton Rubber Co.

The Lagonda Reseating Machine

This machine, which is illustrated in Fig. 1, is intended to remove scale and dirt from the face of tubes, caps and nuts of water-tube boilers after they have been opened for cleaning. It consists of a flat emery stone, $\frac{3}{4}$ inch thick and $6\frac{3}{4}$ inches in diameter, securely held in a cast iron plate. A rod or shaft attached to the back of this plate connects it with a turbine water wheel. The water wheel is contained within a phosphor bronze case, which is provided with an inlet and an outlet for the water.

In operation, the machine is attached to a hose, say $1\frac{1}{2}$ inches in diameter, water being furnished under 75 pounds pressure or more. This operates the emery stone connected to the water wheel, the water passing away through the hose, which is attached to the outlet in the casing. The machine thus equipped is held by the operator, who, passing from tube to tube, applies the emery stone to the faces, a mere touch being sufficient to thoroughly clean and polish them. A spring at the back of the emery plate adjusts it to a perfect bearing. Fig. 2 illustrates the method of cleaning tube ends.

In cleaning caps and nuts the machine is held securely in any convenient position, and while in operation the faces of the caps and nuts are applied to the emery stone.

The practical value of the machine will be readily understood, as it is not only very simple, but is easily handled and operated. It saves time, doing quickly, with one operator, work that often requires several workmen and many hours. The caps, nuts and face of 108 tubes in a B. & W. boiler have been cleaned

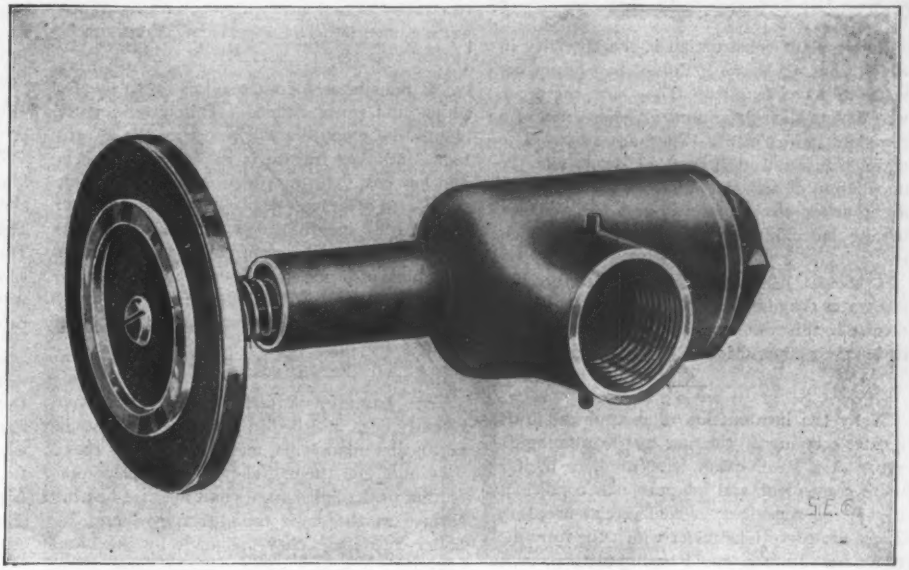


Fig. 1. The Lagonda Reseating Machine

in 55 minutes, and the work thoroughly done. The scale and dirt is not only removed, but the parts polished so that they are quickly and accurately replaced. The device has been thoroughly tested in practical work and is sent on approval. It is manufactured by the Lagonda Mfg. Co., Springfield, O.

A Costly Oversight

In one of the largest of the new buildings in New York, and one that has attracted particular attention, it has been practically decided that the most of the steam piping must come down.

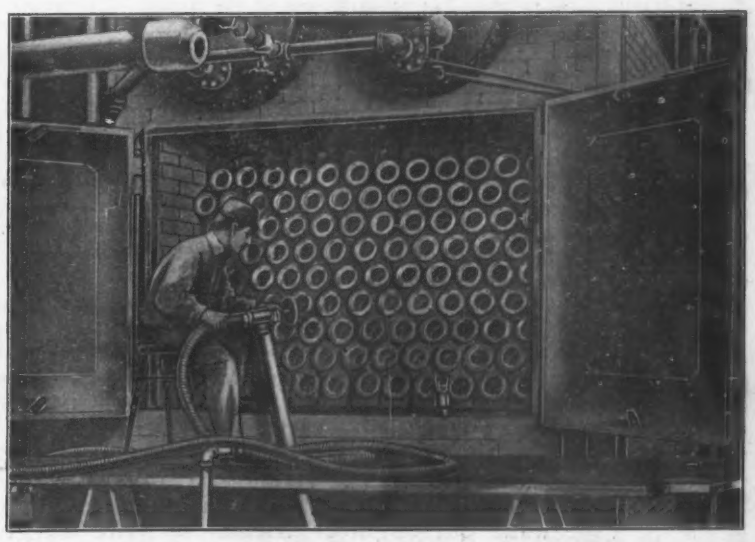


Fig. 2. The Method of Cleaning Tube Ends

It was put up in a hurry and expansion was not allowed for and now it is leaking in every joint. This means a heavy loss to the sub-contractor as well as to the owner.

TRADE NOTES

Power plant construction is the specialty in which Chas. C. Moore & Co., of San Francisco, seem to have excelled. They are engineers, who devote their attention to the erection of a complete power plant. They are prepared to make plans and estimates, or undertake the installation of any class of motive power in all its branches, electric railway or lighting plants, mining and milling machinery, hydraulic work, etc.

A booklet just issued by them decribes and illustrates the numerous plants which have been erected in this country and in the Hawaii Islands under their supervision.

If by the introduction of mechanical draft, greater economy in the first cost or running expense of a steam plant is secured, or if, it is more convenient and adaptable to conditions, it may be considered a commercial necessity. There are conditions under which the introduction of a chinmey would be impractical, or, it might be impossible to further increase the height of the chimney, or, the horse power of a given chimney would have to be increased. In these cases, mechanical draft will have to be used.

The Hartford Blower Co., Suffield St., Hartford, Conn., are experts upon this subject and will be glad to furnish any information desired.

How many of our readers ever bought packing by the gallon? No, its not a joke, nor is it liquid, its "Plastic Metallic Packing," its put up in a gallon and half gallon cans, and will fit any rod. A handsomely illustrated circular and prices will be sent upon request. Address, Heilman-James Co., 523 Locust St., McKeesport, Pa.

A good feed-water heater will pay for itself about as quick as any appliance in a steam plant, and after it pays for itself, it keeps on saving for profits. The Berryman Heater, manufactured by Benjamin F. Kelley & Son, 91 Liberty St., New York City, is so well known, that a description of it here would be superfluous. If any of our readers are in need of a heater they will do well to write this concern for prices. The firm also usually has a few good second-hand heaters on hand, which have been accepted in trade for their latest improved type, and which they will sell cheap.

A sample bar of Stephenson's Belt Dressing will be sent to any reader of THE PRACTICAL ENGINEER who desire to give it a trial. The manufacturers of this dressing say they have built up an enormous business by giving engineers and other belt users an opportunity to test it by actual use without charge. When writing mention THE PRACTICAL ENGINEER.

The Sims filter, for waste oil, is exceptionally simple and easily cleaned. This latter feature is one that engineers will recognize the advantage. Another feature is its convenient form and low cost. No matter whether the amount of oil used is large or small, it will pay for itself within a few months. The Sims catalogue tells more about it. This same catalogue also shows a number of other specialties of interest to engineers. A copy of it will be mailed free to any one mentioning THE PRACTICAL ENGINEER Address The Sims Co., Erie, Pa.

The Lamprey protective arch plates have recently been installed in a number of plants in and near Philadelphia, and the engineers speak very highly of them. They offer effective protection to the boiler fronts and increase heating surface at the same time, thereby increasing boiler capacity. They are made by the Lamprey Co., Westfield, Mass. Philadelphia office, 240 Chestnut St.

Berry's Boiler Feed Control is a mighty compact apparatus that should interest engineers everywhere. Its cost is trifling compared to what it does. A catalogue which describes it thoroughly and states its advantages in detail, will be mailed free to those who are interested. Address Berry Engineering Co., Chester, Pa.

Five years ago the factory of the Norristown Covering Co., was one of the smallest pipe covering concerns in the United States. Now it is one of the largest. This remarkable growth is, doubtless, due to the superior quality of coverings that the company have produced. The big works are now running night and day, and the prospects are, that further enlargement will soon be necessary.

A booklet just issued by the Homestead Valve Manufacturing Co., Box 1754 Pittsburg, Pa., interestingly describes an interesting valve. A copy will be mailed by request.

An interesting little book, entitled "Worth Knowing," and which contains a deal of useful information, will be sent free by the Keystone Chemical Manufacturing Co., Camden, N. J., to any reader mentioning THE PRACTICAL ENGINEER.

Jas. McCrea & Co., 67 West Washington St., Chicago, Ill., the well known makers of the Climax steam joint clamp, the "H. H." steam trap and other specialties, have just installed a new 16" x 36" Bates Corliss engine. This increase in power was made necessary by the largely increased demand for their several specialties. The Fairbanks Co., Albany, N. Y., and the Mica Boiler Covering Co., Montreal, Canada, have each just ordered complete stocks of Climax clamps of all sizes.

The Soot Sucker has always been considered a safe and effective method of removing soot and dirt from the tubes of fire tube boilers. These soot suckers are manufactured by Richard Thompson & Co., 126 Liberty St., New York. This firm also manufactures indicators, reducing wheels, damper regulators, grate bars, etc. A catalogue will be mailed upon request.

The "Utility" apparatus, manufactured by the Standard Steam Specialty Co., 542 West Broadway, New York, has recently been adopted by Peyton Chemical Co., National Biscuit Co., Broadway Chambers Building, Musuem of Natural History, Hotel Belmont, Kernan's Theatre, Times Building, Runkel Bros., Dewey Apartment Hotel.

The Peerless Rubber Manufacturing Co., 16 Warren St., New York City, have just issued their new illustrated catalogue, No. 60, describing their superior mechanical rubber goods. It describes the uses of their well known "Rainbow Packing," as applied in any kind of steam, air or hot water joint; the "Eclipse" sectional rainbow gasket, which will fit any hand-hole or man-hole made; the "Peerless" piston and valve rod packing, which will tightly pack any rod up to a pressure of 400 pounds, and which they make in three different shapes; round, square and spiral, to meet different conditions. It also describes their "Peerless" expansion ring packing, made in rings to exactly fit any piston rod and box; "Dale's" high pressure automatic steam trap packing; "Hercules" combination metalic stop valve packing, and their arctic packing, which is especially constructed for ice machines.

The catalogue contains many useful tables that are of use to every engineer, such as methods for finding the length of belt, methods of lacing belts as well as a number of useful notes on leather belting. Besides these well known supplies, that are used in the engine room, The Peerless Rubber Manufacturing Co. also carry a complete line of leather belting, rubber hose for all uses, pump valves, gauge glass rings and rubber mats and matting.

An inquiry to the above address will bring this very valuable catalogue to you.

We want our engineer friends to write us, giving their experiences and ideas. Never mind the grammar or the drawing, we will attend to that, its the ideas that we want.

The practical uses of graphite are probably as varied as any substance employed in the arts, and none of these uses is more rapidly increasing than as a lubricating material. The purpose of a booklet just issued by the Joseph Dixon Crucible Co., of Jersey City, N. J., is to describe their line of lubricating greases and compounds in which graphite is an ingredient. The Dixon Company are the pioneers in the graphite business and are the only house that handles graphite in every form, and supply it for every purpose for which it is used. To the Dixon Company must be given credit for having brought the matter of graphite lubrication to its present condition of importance in the mechanical field. They have been engaged in the business for over 80 years.

Along with the rapid progress of steam engineering, the feed water heater has now taken its place as a necessary adjunct to the steam plant. The economy accomplished by the use of a feed water heater has become a standard fact, and the saving in cost of fuel varies from 15 per cent. to 25 per cent., according to varying conditions.

The Pittsburg Feed Water Heater Co., 1717 Frick Building, Pittsburg, Pa., have just issued a catalogue describing their feed water heaters and purifiers, which not only contains a description of the open type of heater, but a list of testimonials from engineers and companies who have used them. This company also manufactures the Bonar gauge cock, and the Bonar oil filter, separator and purifier, all of which are shown in the catalogue, a copy of which will be mailed gratis upon request.

The Sterling Pipe and Blower Co., Hartford, Conn., make exhaust heads. Large ones, small ones, good ones. Make them quick and well. An exhaust pipe, like every other "business," needs a head, and the Sterling head is a good one.

W. Clifford Smith, 140 North Sixth St., Philadelphia, informs us that he has recently received many orders through his advertisement in THE PRACTICAL ENGINEER, for Smith's clamps for stopping leaks in pipe joints. These clamps have now been in service for more than two years, and Mr. Smith says they are giving excellent satisfaction everywhere. They are made in sizes from ¾" to 20" in either brass or steel. They can be quickly and conveniently applied while pressure is in pipe. Illustrated circulars and prices will be mailed upon request.

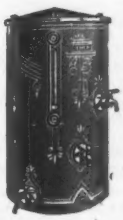
St. John Cylinder Packing has been used so extensively and with such general satisfaction to engineers, that most engineers now specify it whenever a cylinder packing is required. H. B. Underwood & Co., 1025 Hamilton St., Philadelphia, who have the largest engine repair establishment in the United States, have manufactured it for many years and use it exclusively in all their work, in many cases it has been in constant service for more than ten years and is still in perfect condition.

The Burt Mfg. Co., Akron, O., recently filled an order for four Cross Oil Filters from Buenos Ayres, Argentine Republic.

IF ENGINEERS will send $1.00 to the address below they will receive two blue prints, with tables and instructions, showing how to set valves and eccentrics on Corliss engines, simple and compound, with one and two eccentrics. JOHN T. LINDSTROM, 214 and 216 S. 3d St., Allentown, Pa.

IT PAYS TO BE INTERESTED

in the economy of your plant. If you have a steam plant you should that the **CROSS OIL FILTER** will save you 50% in your lubricating bills, because it cleans the oil you usually throw away as useless. Have you got the filter? If not send for one on 30 days' trial, and if not satisfactory return at our expense.



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cover the very points you and I have in mind, and there's the **Catalogue 16-S** of the Cochrane Separators full of interesting information about Separators, their design, construction, dimensions, styles, how to install and drain them, etc.

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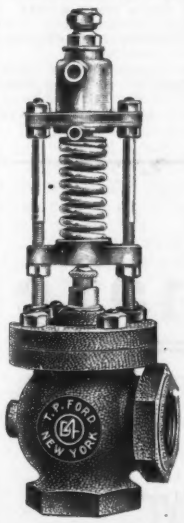

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American Order of Steam Engineers.

ORGANIZED APRIL 27, 1886.

An Order of Engineesr for Engineers and Engineers only.

DECLARATIONS OF PRINCIPLES

Believing that ability will bring its full value in this country, this Order shall at no time take part in strikes, nor in any way interfere between employer and employees. Recognizing their identity of interests, it shall take no part in any project or enterprise that shall interfere with perfect harmony between them; neither shall it be used for political or religious purposes.

These principles shall not be amended or repealed except by unanimous vote of the Order.

Any member who shall be guilty of violating the principles of the Order shall be expelled.

OBJECTS.

First.—To promote a more thorough knowledge in its members of theoretical and practical steam engineering.

Second.—To assist members to obtain employment.

Third.—To help the sick, injured and distressed and bury the dead.

Fourth.—To establish a Widows' and Orphans' Fund.

Fifth.—To help members who shall become incapacitated from following the profession to obtain employment suited to their affliction.

Sixth.—To do our utmost to extend the license law throughout the United States.

Seventh.—To establish schools in which our members may study the highest branches of steam engineering.

MEMBERSHIP.

An applicant for membership must be an engineer between twenty-one and fifty years of age, and must be a white male citizen of the United States, of good moral character and be a believer in the Supreme Being, and be free from all physical infirmities.

He must have had three years' service in an engineering department, or if a machinist, or graduate of a technical institute, then one year's service, in such department, and in localities where engineers are required by law to be licensed, they must have such license, and must satisfy the investigating and examining committees of the council to which he applies as to his character and ability.

LIFE MEMBERSHIP.

Engineers who have passed the age limit may be admitted to life membership. They must possess the same qualifications and pass the same examination as are required in the next proceeding clause: They shall be entitled to all rights and privileges of the Order except they cannot vote on financial questions or for the election of officers or be entitled to any sick or death benefits.

DIRECTORY.

The Publication Committee of "The Practical Engineer" desires that the Corresponding Engineers of all Councils of the American Order of Steam Engineers send the name of their Chief Engineer and their own name and address, together with the time and place of meeting, to the Secretary of the Publication Committee immediately after each election of officers. Address J. C. McDowell, Secretary, in care of "The Practical Engineer," 1215 Filbert Street, Philadelphia.

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Deputy Supreme Chief Engineer, David J. Stayton, No. 513 Searles St., Wilmington.

WILMINGTON.

Delaware Council, No. 1, meets every Wednesday at S. E. Cor. Fourth and King Sts. Chief Engineer, Clark Franklin. Corresponding Engineer, A. E. Deakyne, 406 Lombard St.

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JENNINGS.

Jennings Council, No. 2, meets every Saturday evening in American Bank. Chief Engineer, Daniel R. Jones. Corresponding Engineer, R. E. Funk.

MARYLAND.

Deputy Supreme Chief Engineer, A. J. Deidrich, 226 North Caroline St., Baltimore, Md.

BALTIMORE.

Maryland Council, No. 1, meets 2nd and 4th Fridays in Royal Arcanium Hall. Chief Engineer, L. Smithers. Corresponding Engineer, Wm. S. Smith, 523 Sharp St., Baltimore.

Energy Council, No. 2, meets every Wednesday of each month in Bauer Hall, Chesapeake and Elliott Sts. Chief Engineer, T. E. Eaton. Corresponding Engineer, Thos. O. Daneker, 834 East Ave.

MASSACHUSETTS.

Deputy Supreme Chief for Eastern District, W. E. Packard, Whitmann.

BOSTON.

Boston Council, No. 4, meets 2nd and 4th Thursdays of each month, in the Hall, 262 Washington St. Chief Engineer, A. R. Abbott. Corresponding Engineer, Phillip Sanford.

ROCKLAND.

Old Colony Council, No. 14, meets 2nd and 4th Saturdays in the American Foresters' Hall. Chief Engineer, Herbert W. Jones. Corresponding Engineer, James K. Sedgwick, Box 333, Rockland, Mass.

NEW JERSEY.

Deputy Supreme Chief, F. O. Garrison, Bridgeton, N. J.

PERTH AMBOY.

Stevens Council, No. 1, meets 3rd Saturday, at Water, near Lafayette St. Chief Engineer, Lawrence Oliver. Corresponding Engineer, James H. White.

CAMDEN.

Camden Council, No. 3, meets every Thursday evening at S. E. corner 2d and Arch Sts. Chief Engineer, S. M. Best. Corresponding Engineer, C. H. Pfeiffer, 571 Berkley St.

ATLANTIC CITY.

Atlantic City, No. 4, meets every Tuesday evening at Merchants, Cor. Atlantic and New York Aves. Chief Engineer, John A. Best. Corresponding Engineer, W. S. Price, Haddon Hall.

BRIDGETON.

Bridgeton Council, No. 5, meets every Friday. Chief Engineer, David Sellers. Corresponding Engineer, Francis O. Garrison, Bridgeton, N. J.

MILLVILLE.

Millville Council, No. 6, meets every Saturday, 7.30 P. M., in G. A. R. Hall, East Main St. Chief Engineer, Wm. F. Pond. Corresponding Engineer, Lewis Doughty, 604 Mulberry St.

NEW YORK.

SYRACUSE.

John E. Sweet Council, No. 6, meets Monday, Room 23, Nottingham Block, East Washington St. Chief Engineer, John Cunningham. Corresponding Engineer, S. A. Steel, 311 Orange St.

PENNSYLVANIA.

Grand Chief Engineer, Hiram Trout, 1042 Locust St., Reading, Pa. Deputy Grand Chief for Philadelphia and Delaware Counties, John P. Rickards, 2707 N. Broad St., Philadelphia. Grand Corresponding Engineer, Frederick Markoe, 931 Orianna St., Philadelphia.

Deputy Grand Chief for Western Pennsylvania, A. D. Hamilton, 2025 Forbes St., Pittsburg, Pa.

PHILADELPHIA.

Germantown Council, No. 22, meets every Wednesday evening at Main and Seymour Sts., Germantown. Chief Engineer, George T. Lee. Corresponding Engineer, Frank MacIndoe, 3519 Ainsley St., Falls of Schuylkill, Philadelphia.

Welcome Council, No. 2, meets every Friday, N. W. Cor. Twelfth St. and Columbia Ave. Chief Engineer, Paul Pieling. Corresponding Engineer, L. D. Woodington, 2428 N. Bancroft St.

Kensington Council, No. 3, meets every Thursday, at A. P. A. Hall, Frankford Ave. and Master St. Chief Engineer, Ed. C. Ricker. Corresponding Engineer, Ernest Ritsert, 2229 Frankford Ave., Philadelphia.

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Philadelphia Council, No. 7, meets every Wednesday, at Kenny's Hall, N. W. Cor. Broad and Filbert Sts. Chief Engineer, Harry Dunn. Corresponding Engineer, W. S. Wetzler, 3717 Aspen St.

Manayunk Council, No. 9, meets 2nd and 4th Friday evenings in Temperance Hall. Chief Engineer, Andrew Roberts, Sr. Corresponding Engineer, John Clevenger, 211 Lofty St.

Helping Hand Council, No. 12, meets every Tuesday evening at the Hall, 2550 Emerald St. Chief Engineer, Edward Laurence. Corresponding Engineer, Frank McHugh, 2503 Tulip St. All correspondence should be addressed direct to the Council.

Municipal P. F. D. Council, No. 20, of Philadelphia, meets the second Thursday of each month at Odd Fellows' Hall, Third and Brown Sts. Chief Engineer, Daniel Bunting. Corresponding Engineer, Walter Meyers, 1211 North Howard St.

PITTSBURG.

Iron City Council, No. 21, meets every Saturday at Arnfeld Hall, 1119 Penn Ave. Chief Engineer, J. J. Stewart. Corresponding Engineer, Alex. Fraser, Carnegie, Pa.

GIRARDVILLE.

Girard Council, No. 8, meets every Tuesday evening at O'Neill's Hall, Second and Ogden Sts. Chief Engineer, Jacob Weber. Corresponding Engineer, M. J. Carey, Lock Box 214.

ALLENTOWN.

Lehigh Council, No. 15, meets every Wednesday evening at 639 Hamilton St. Chief Engineer, John evening at 639 Hamilton St. Chief Engineer, Henry C. Snyder. Corresponding Engineer, A. P. Driesbach, 728 Chew St.

POTTSTOWN.

Pottstown Council, No. 14, meets 1st and 3rd Saturday evenings at P. O. S. of A. Hall, Cor. High and Hanover Sts. Chief Engineer, Chas. Quinter. Corresponding Engineer, H. L. Shirey, 362 Cherry St.

READING.

Progress Council, No. 13, meets every Saturday evening at Diebert Hall, Ninth and Penn Sts., Room 4. Chief Engineer, John Kellenberger. Corresponding Engineer, Frank S. Miller, 3 West Franklin St.

CHESTER.

Delaware County Council, No. 6, meets every Wednesday evening in the Carpenter Hall, Sixth and Wall Sts. Chief Engineer, John Canavan. Corresponding Engineer, E. E. McCoy, 2222 West Third St.

YORK.

York Council, No. 16, meets every Wednesday Evening in the Jordan Block. Chief Engineer, A. L. Bair. Corresponding Engineer, Walter H. Long, 23 East Philadelphia St.

HARRISBURG.

Capitol City Council, No. 17, meets every Tuesday evening in Red Men's Hall, Market St., above Second. Chief Engineer, B. H. Shafer. Corresponding Engineer, S. Filson, 1126 Market St.

COLUMBIA.

Columbia Council, No. 18, meets every 1st and 3rd Saturdays, in Odd Fellows' Hall. Chief Engineer, John McLane. Corresponding Engineer, W. J. Courtney, 804 Walnut St.

SUNBURY.

Sunbury Council, No. 19, meets every Monday evening in Zartman's Hall. Chief Engineer, R. D. Mantz. Corresponding Engineer, Ed. Schrieber.

WISCONSIN.

Deputy Supreme Chief Engineer, Joseph P. Harris, No. 1611 Clybourn St., Milwaukee.

MILWAUKEE.

Washington Council, No. 1, meets every Saturday at 207 Grand Ave. Chief Engineer, J. B. Chambers. Corresponding Engineer, James A. Rigby, 136 Reed St.

Clifford P. Williams Council, No. 2, meets every Monday evening at Lodge Hall, E. Water St. Chief Engineer, J. T. Harris. Corresponding Engineer, Joseph T. Harris, 1611 Clybourn St.

TENNESSEE.

Deputy Supreme Chief Engineer, John B. Mullen, 826 Central Ave., Nashville.

NASHVILLE.

Enterprise Council, No. 1, meets every Friday evening in the Twin Building on Cedar St. Chief Engineer, J. J. Johnson. Corresponding Engineer, Jno. B. Mullen, 209 Jackson Building.

OREGON.

Deputy Supreme Chief Engineer, Nat. Freese, Grant's Pass, Oregon.

GRANT'S PASS.

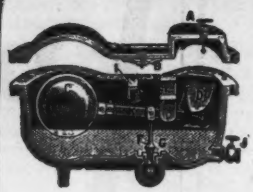
Oregon Council, No. 1, meets every 1st and 3rd Saturday in A. O. U. W. Hall, Main St. Chief Engineer, William H. Kenny. Corresponding Engineer, Nat Freese.

TEXAS.

Deputy Supreme Chief Engineer, S. A. Bisbey, care of Cotton Compress and Warehouse Co., Galveston.

GALVESTON.

Galveston Council, No. 1, meets every 2nd and 4th Tuesday evenings at Engineers' Hall, S. W. Cor. Twenty-second and Strand Sts. Chief Engineer, Max Levy. Corresponding Engineer, A. L. Bradford, Union Depot.



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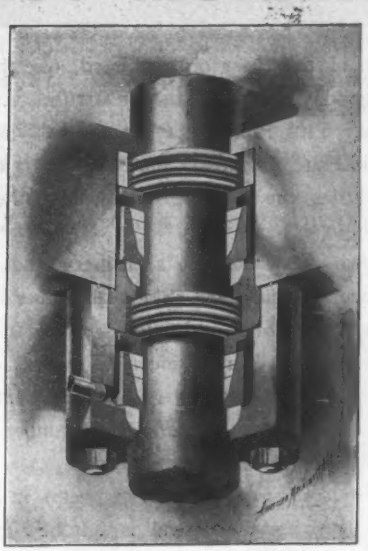

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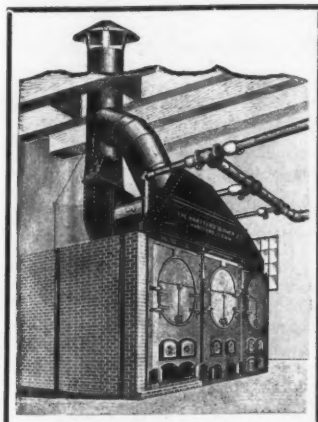

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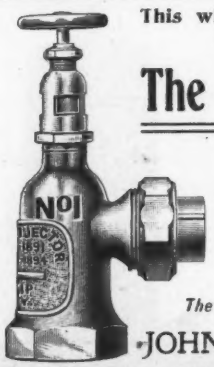

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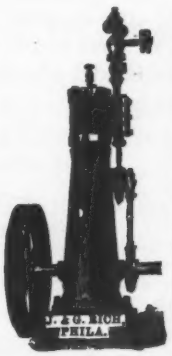

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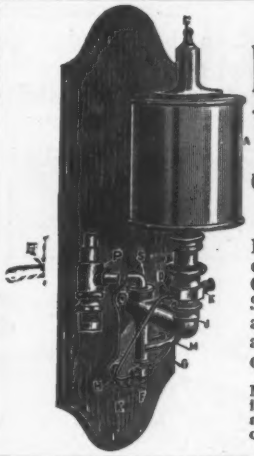

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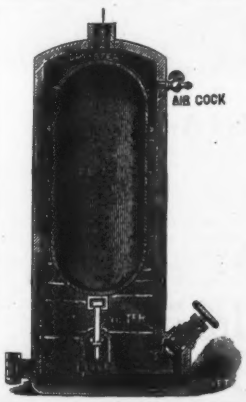

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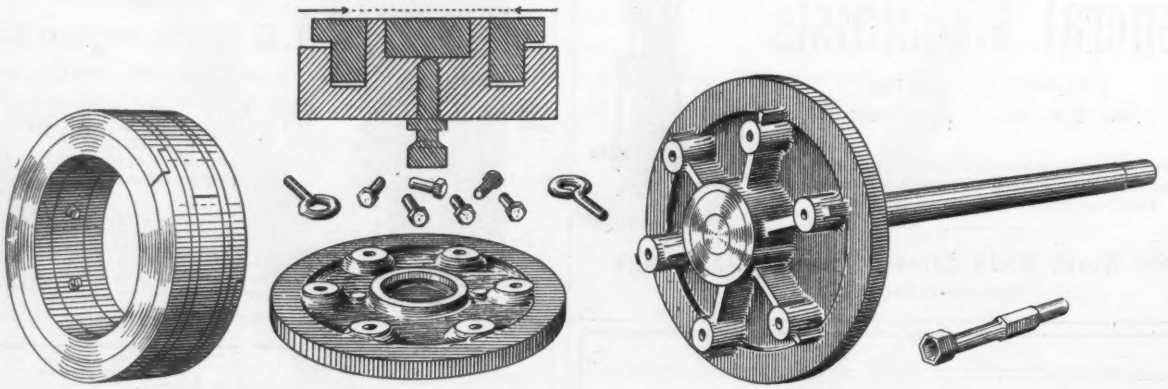

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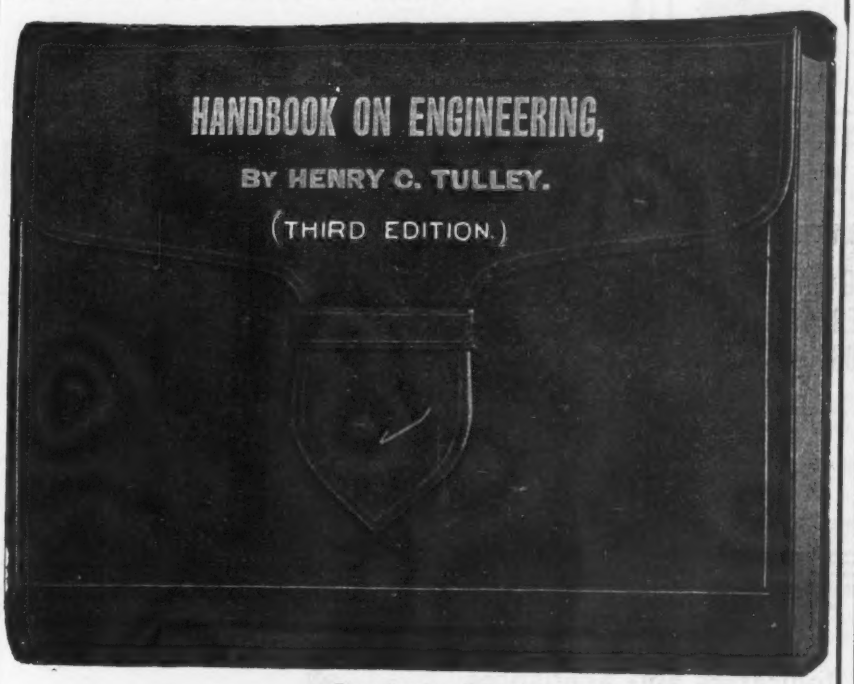

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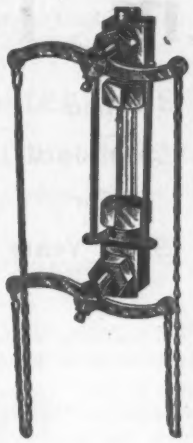

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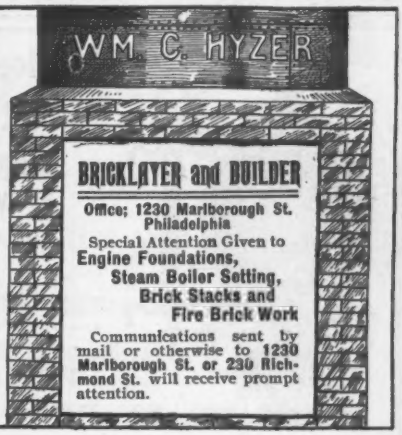
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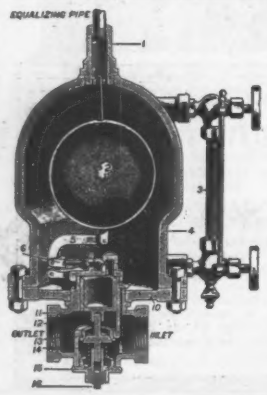

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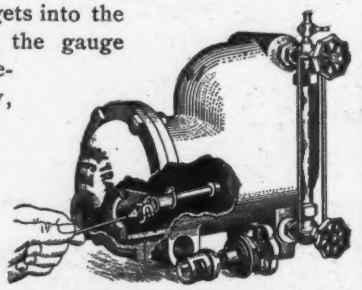

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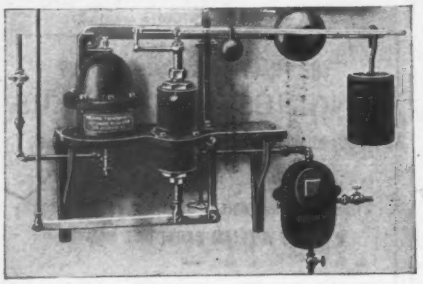

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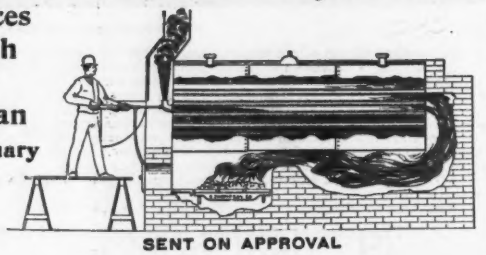

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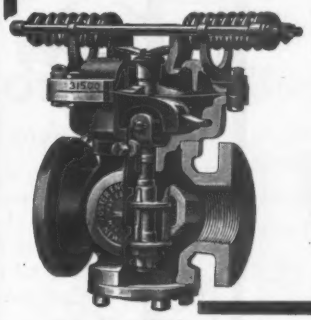

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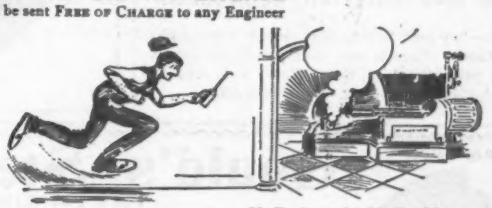

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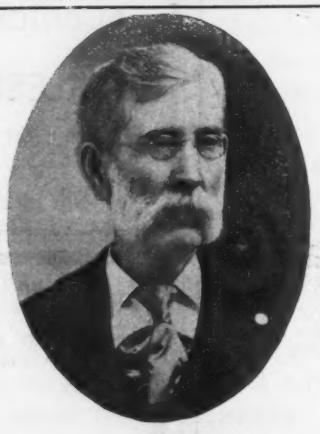

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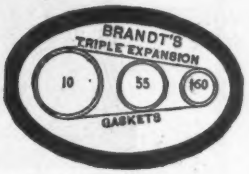

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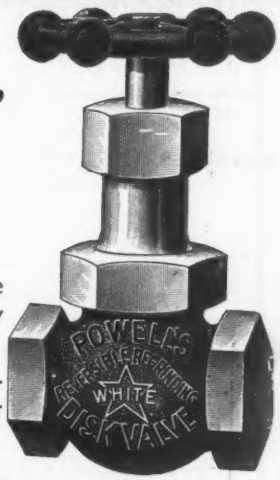

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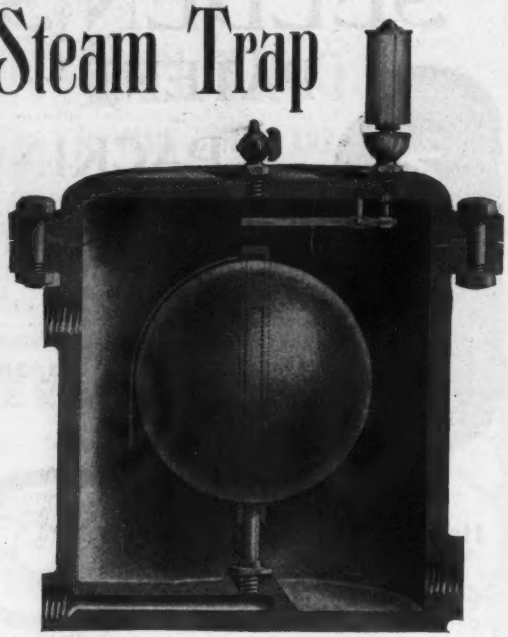

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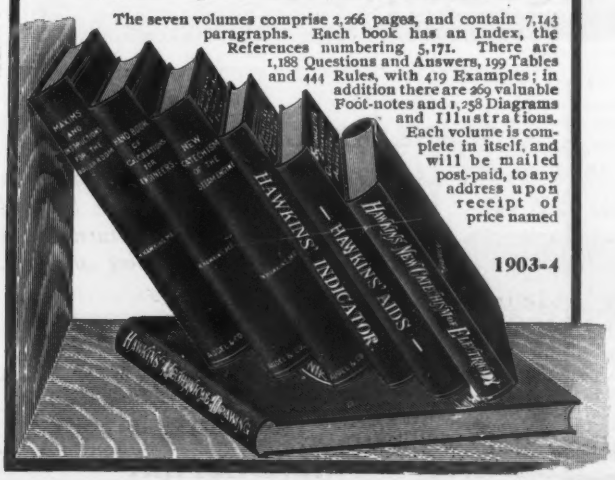

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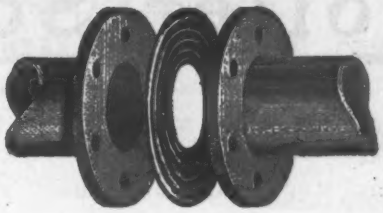

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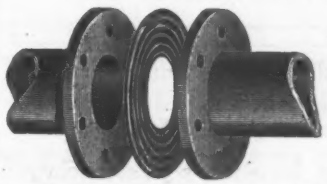

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PHILADELPHIA, PA. U.S.A.

October 20th, 1903.

The sample of water marked
from Artesian Well 500 feet deep submitted by
for analysis, contains as follows:

Organic and Volatile	8.462	Grs.	Per	U. S.	Gallon.
Sodium Chloride	4.957	"	"	"	"
Calcium Sulphate	5.451	"	"	"	"
Calcium Carbonate	3.061	"	"	"	"
Magnesium Carbonate	1.942	"	"	"	"
Magnesium Chloride	5.102	"	"	"	"
Total Solids	28.975	"	"	"	"

Chief Chemist

SCALE ANALYZED FREE

Send a sample of the water you use or a piece of scale from your boiler, we will analyze it free of cost and return you a certificate as above, showing analysis.

Geo. W. Lord Co.

2238-50 N. Ninth Street
PHILADELPHIA

YOU DON'T BUY an OIL FILTER EVERY DAY

You don't want to buy one every day.

When you do get one, you want it to last, and to filter oil. If you haven't already bought a filter, or if the one you have happens to be the kind that neither lasts or filters, let us send you an ACME on trial, after a little time you'll find it well worth the money we ask for it.

Walter L. Flower & Co.
810 Chemical Building
ST. LOUIS, MO.

THE ROSE PATENT GRATE

A THOROUGHLY UP-TO-DATE SHAKING GRATE FOR PARTICULAR ENGINEERS. WRITE FOR CATALOGUE.

THE KUTZTOWN FOUNDRY AND MACHINE COMPANY

MAKERS OF HIGH GRADE

Boiler Fronts, Grate Bars, Furnace Castings, Compound Separators, and General Boiler Castings

Works: KUTZTOWN, Penna.

Philadelphia Office: Fidelity Building, Broad, above Arch

STEAM FITTING

if not properly done, in any plant, will cause the engineer a great deal of trouble, and his employer unnecessary expense. Many years of practical experience and a force of competent assistants enables me to guarantee absolute satisfaction.

WILLIAM MILLIGAN, Shop, 726 Sansom St., Philadelphia, Pa.

'Phones: { Bell-Market 37-99a / Keystone-Main 1-71

JOBBING A SPECIALTY

HARTFORD STEAM BOILER INSPECTION AND INSURANCE CO. HARTFORD, CONN.

RED SEAL BOILER COMPOUND

RED SEAL BOILER COMPOUND

WILL REMOVE SCALE AND GREASE FROM STEAM BOILERS

MANUFACTURED BY

THE CHERRY CHEMICAL CO.

OLIVER BRADEN, Manager

Office: 1215 Filbert Street, - - Philadelphia, Pa.

Circulars, Prices and Directions Furnished on Application.

RUST RUIN

Stop it. Water eats iron, rust corrodes, corrosion neglected may mean one or a battery of boilers out of service.

Wisconsin Graphite Paint

does the work that stops the loss. It's metal life with merits that make it best.

WISCONSIN PITTSBURG, PA. GRAPHITE CO.

Write today for prices and samples.

WISCONSIN GRAPHITE COMPANY, PITTSBURG, PA.

Watt's Perfect Wedge Packing

FOR EITHER HIGH OR LOW PRESSURE

Holds steam, water, air or ammonia with less friction on the rod than any other. Write for trial order to-day.

Watt's Best Sheet Packing

It is best because it makes any kind of a joint tight and keeps it tight. Used for oil, acid, steam, ammonia and water. It is the lightest and purest Rubber Packing made and can be used over again, and will not become hard under the highest steam pressure.

WATT'S HIGH PRESSURE BEST OIL PROOF

Manufactured by JOHN M. WATT'S SONS

24 Duane St., New York 123 S. Second St., Phila., Pa.

GRATE BARS OF ALL KINDS, AND GENERAL CASTINGS TO ORDER

LOW PRICE AND GOOD QUALITY. LET US CALL AND GIVE QUOTATION ON YOUR WORK.

Smith's Clamp for stopping leaks in pipe joints. Cheapest, simplest and most effective Clamp ever manufactured. Costs less than $1.00 per inch in diam. and much less in steel.

W. CLIFFORD SMITH,

Steam Specialties and Castings of Every Description. 140 N. Sixth St., Philadelphia.

Let us have your name, please?

We want to send you a supply of our new patented four-wedge

Black Squadron Ring Packing

It will cost you nothing, for we send it

FREE—EXPRESS PAID

WE don't ask you to invest one cent, we take all that part upon our shoulders. What we ask is that you pack a stuffing-box with what we send you and watch the results.

After all, this is the only sure way of convincing you that the principle as well as operation of **Black Squadron Ring Packing** cannot be improved upon.

Black Squadron Ring Packing

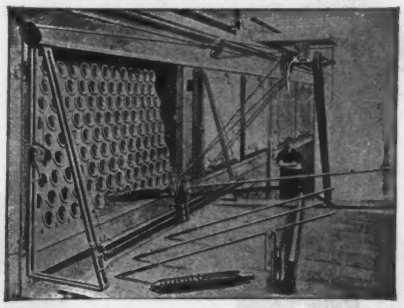
Will outwear, outlast any other adjustable or self-setting packing on the market, and it is by far the most economical of any packing that you can use. We want you to gather this evidence for yourself; after you are satisfied, thoroughly satisfied, we'll talk business.

Every engineer who has the least desire to take advantage of improved means and methods, should look into our claims.

With the packing we send a valuable book of information called "THE ENGINEER." Book comes FREE also.

Cancos Manufacturing Co.

146 N. Second Street, Philadelphia, Pa.



The Union Boiler Tube Cleaners

POWER OR IMPULSE

Are the oldest and most efficient Boiler Tube Cleaners on the market. They take out all the scale.

The Gem Flue Scraper

does the same for Smoke Flue Boilers.

We also make **Gem Oilers,** Patent or Plain, **Torches and Heavy Brazed Steel Oilers, Flexible Shafting, Loose Pulley Lubricator.**

WRITE FOR CATALOGUE AND PRICES.

GEM MANUFACTURING CO.

Spruce near 33d Street Pittsburg, Pa.

The Lagonda Reseating Machine

FOR CLEANING FACES, NUTS AND CAPS OF BOILER TUBES

IT'S A MONEY-SAVER

Doing in one hour with one operator, work that requires several men many hours. Machine does perfectly what men do indifferently. **No Refitting of Caps Required.** Sent on approval.

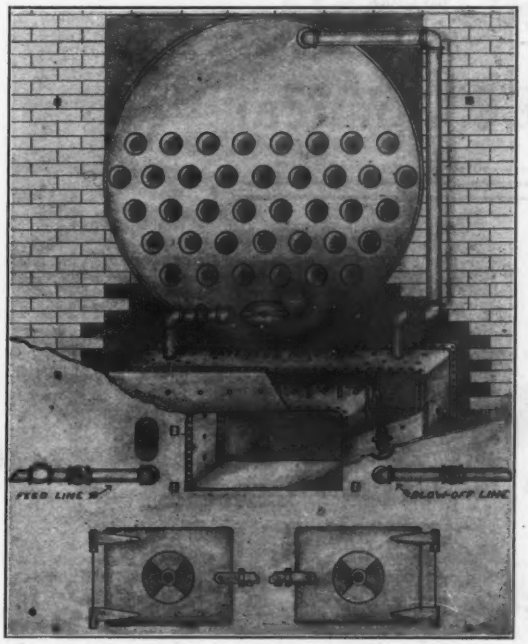
SEND FOR CIRCULARS, ETC.

WEINLAND TUBE CLEANERS ARE UNEQUALLED

THE LAGONDA MFG. CO., BOILER CLEANING EXPERTS

SPRINGFIELD, OHIO.

STEEL WATER ARCH



Saves the need of renewing brick arch; lasts as long as the boiler; increases capacity; does the work of a feed-water heater, and saves its cost in coal in a few weeks. You can't afford to be without it.

NEIL W. MAC INTOSH & CO. STEAM FITTERS

54 John Street - - - - NEW YORK

Lamprey Protective Arch Plates

Protect your boiler fronts from burning out, preserve the brick work, save fuel, and increase the efficiency of your boiler, by giving additional heating surface. Save their cost in repairs alone.

Send for Catalog

THE LAMPREY CO.

Westfield, Mass.

Philadelphia Shop, 240 Chestnut St.

"Teon" Belting

The only belt that will stand **230 degrees** Fahrenheit, **18 degrees above boiling.** It is **water-proof** and not affected by exposure to **chemical actions, etc.** Having enormous strength and splendid driving surface, and being lighter in weight than leather, it will transmit more power than any other belt. For use in exposed places and under adverse circumstances, "Teon" has no equal. Every belt sold with the **guarantee** if not as represented, **money will be refunded.** Send for catalogue showing tests, etc.

D. P. BROWN & CO.

IMPORTERS OF

POWER PLANT SPECIALTIES

SOLE IMPORTERS AND U. S. AGENTS

262 and 264 North Fourth St. PHILADELPHIA

Brown's **Oil-proof** Ring Packing with Imported Compound Cushion and Special Metallic Protection.

Brown's Imported **Oil-proof, Non-vulcanizing** Sheet Packing.

Brown's Universal Spring Steel **Packing Hooks** (six in a set) will fit in any box.

Use it to Clean the Boilers

DEAR

Vegetable Treatment—
Condensed—Economical

DEARBORN DRUG &

120 Liberty Street, NEW YORK

Philadelphia Office

BORN

Use it to Keep the Boilers Clean

One gallon of water required for Analysis

CHEMICAL WORKS

Rialto Building, CHICAGO

The Bourse

Electrical Repairing

And General Machine Jobbing

We have the best equipped shop in Philadelphia for the execution of Electrical Repair, as well as General Machine Work and earnestly solicit your business along these lines. We guarantee you the best of work at a reasonable price, it will be finished when promised, and will be satisfactory.

Many of Philadelphia's Largest Concerns are Our Satisfied Customers

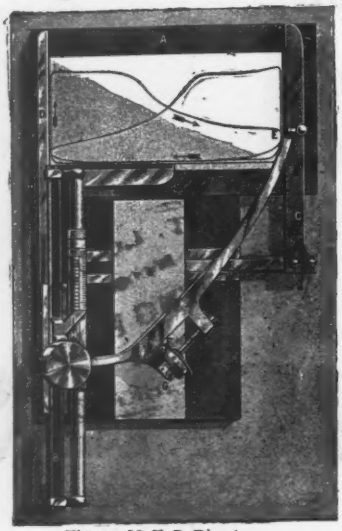
Thos. H. Dallett Company

BELL PHONE
Tioga, 24-75

Twenty-third and York Streets, Philadelphia, Pa.

BUSHNELL

Improved Planimeter



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Simple, Easily Manipulated.
No chance for error.
Compact, Complete in Carrying Case 1¼" x 4" x 8"
Accuracy Guaranteed.

WE ALSO MANUFACTURE THE

Bachelder Adjustable Spring Indicator

Complete for any pressure

The Ideal Reducing Wheel

Complete for any Stroke

The Soot Sucker Boiler Tube Cleaner

CLEANS the tubes without admitting steam into them

BUSHNELL

Cord Take-up

Attached to Bachelder Indicator with Ideal Reducing Wheel

Takes up the slack cord and puts it back where it belongs at the proper time.
No tangling or breaking of cord.

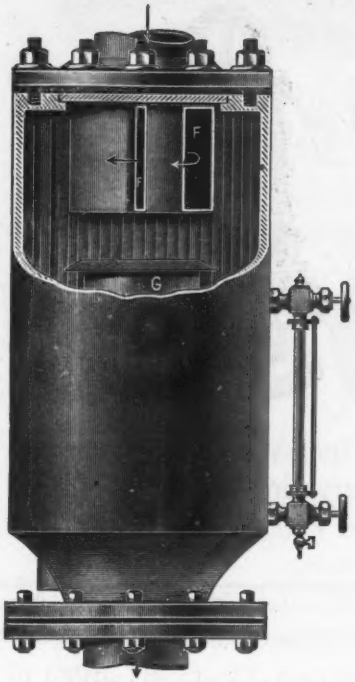
SEND FOR CATALOGUE A

JOHN S. BUSHNELL CO.

126 Liberty Street
New York, N. Y.

The Sims Steam Separator

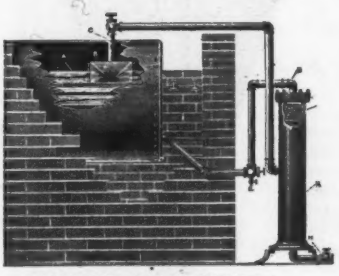
FOR VERTICAL PIPE



PATENTED APRIL 1, 1902

THE

Sims Automatic Boiler Cleaner



THOUSANDS IN SUCCESSFUL OPERATION

Our prices are low
Our quality high
Our efficiency great
If in need, buy

Schade & Marshall

Philadelphia Representatives

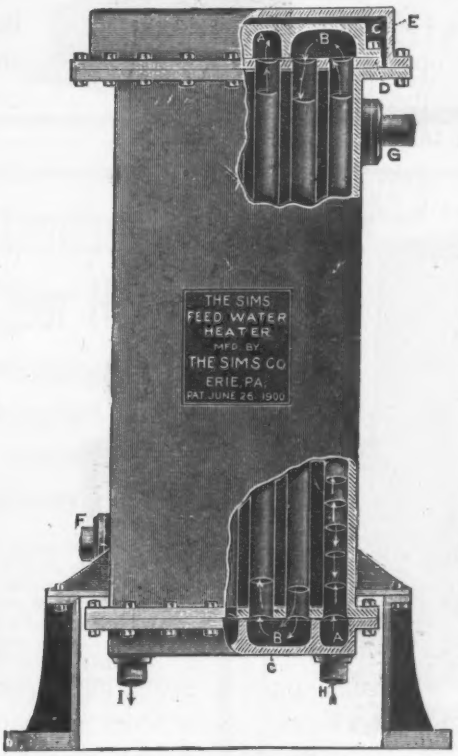
The SIMS Co.

Erie, Pa.

—MANUFACTURERS OF—

Mechanical Boiler Cleaners.
Feed Water Heaters.
Oil Filters.
Steam Separators.
Oil Extractors.
Exhaust Heads.
Low Water Alarms.
Boiler Compound Feeders.
Kerosene Oil Injectors.
Oil Cups.
Flue Blowers, Etc.

Write for Illustrated Catalogue.

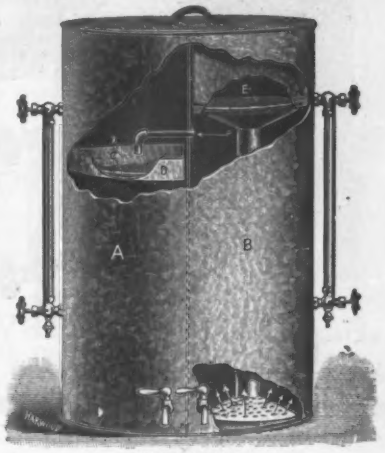


VERTICAL HEATER

The only feed water heater that has perfect circulation of feed water through every tube at the same time, constructed so the tube can be readily scraped.

This is the Oil Filter you require if you want the best results at lowest cost—

The "SIMS" Filter



PATENTED

The "SIMS" Low Water Alarm

ST. READ PUBLIC LIBRARY

A SAMPLE ORDER AFTER MONTHS OF COMPETITION WITH OTHER ALARMS

ELLSWORTH, PA., Sept. 5th, 1903.
THE SIMS CO., Erie, Pa.,
Gentlemen:—

We have tested your alarms and find same quite satisfactory, and enclose herewith an order for thirty (30). You understand that you have to furnish us with (29) more and render us the bill for the whole thirty. We shall be glad if you will dispatch the same as soon as possible.

And oblige yours truly
JAMES W. ELLSWORTH & Co.

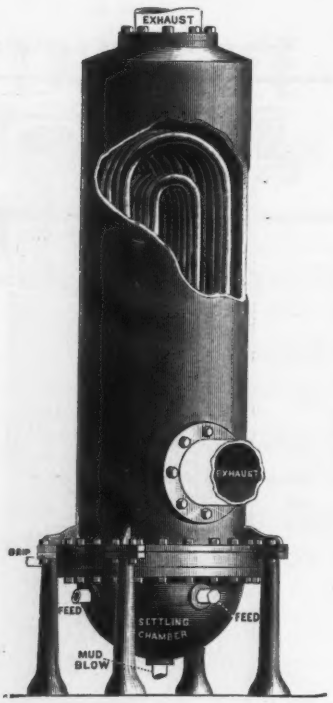
PATTERSON Steam Specialties

Are All Sold on Thirty Days' Trial, to Be Returned at Our Expense if Unsatisfactory

The interior construction and operation of our separators are described in the October issue of THE PRACTICAL ENGINEER, but we can't help again reminding you of that large hand hole for inspection and cleaning without disconnecting the pipes.

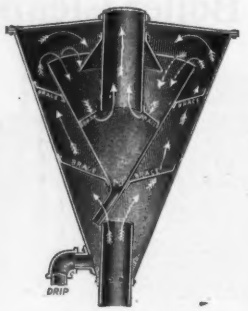
DID you ever consider how extravagantly steam pumps use steam? The power required to run a belt pump would hardly be missed.

These are simple, strong and very reasonable in price.



The sales of the Patterson-Berryman Feed Water Heater and Purifier keep right on increasing.

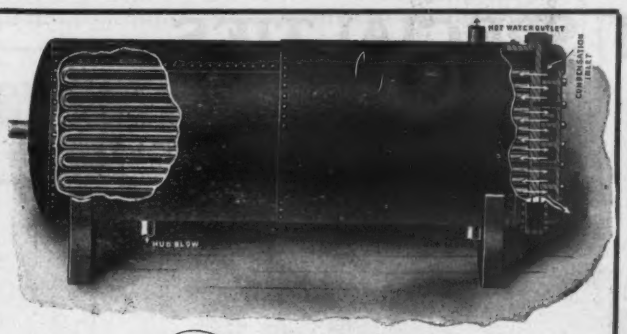
It's the old stand-by. No oil in the boilers, no trouble of any kind. You can't afford to experiment, even if the other fellow's is a little bit cheaper (at first) than this famous little fuel saver.



Are you tired of the way that exhaust pipe is spattering greasy water over everything, including your clothes? Perhaps the neighbors are too. If a Patterson Exhaust Head won't stop the trouble, don't pay us a cent for it.

Frank L. Patterson & Co.

24 Cortlandt Street, New York



The Cleaner

TRADE MARK

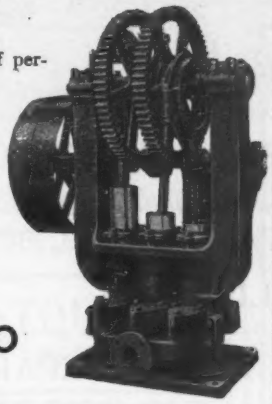
The **Cleaner** represents the acme of perfection in feed water heating.

The Davis Triplex Power Pump

is a perfect type of the vertical triplex belt driven pump.

Manufacturers of
The "Berryman" Feed Water Heater and Purifier

I. B. DAVIS & SON
HARTFORD, CONN.

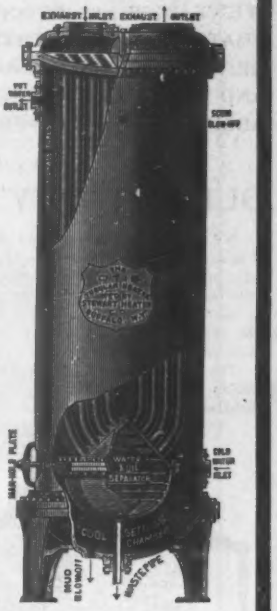


WRITE FOR CATALOGUE, ETC., TO

THOS. McADOO
125 NORTH 4TH ST.
PHILADELPHIA

The OTIS Tubular Feed Water Heater, Oil Separator and Purifier

with Seamless Brass Tubes



Guaranteed

To heat the feed water to the boiling point (210 or 212 degrees) with the exhaust steam without causing any back pressure, **also to extract the oil from the exhaust,** so that the exhaust steam after being passed through the heater can be used for heating purposes, and the water of condensation for the heating system be returned to the boiler without the additional expense of an eliminator.

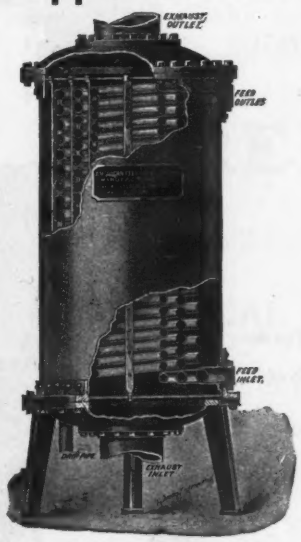
A Liberal Offer

If this heater fails to give satisfaction in every respect, we pay freight, cartage, etc., both ways.

The Stewart Heater Co.

11 Norfolk Ave., Buffalo, N. Y., U. S. A.

The American Standard Copper Coil Feed Water Heater



Simplicity!
Strength!
Economy!
A Money Saver!

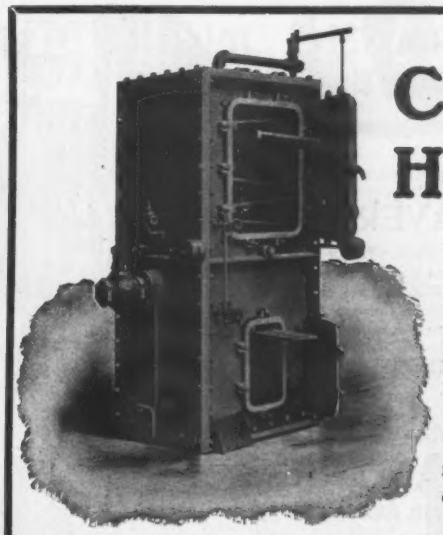
It gives so little trouble that one of our customers, who has used one for 8 years, had forgotten that he had it when we asked him the other day how it was doing. He called in the engineer, who said it hadn't been touched since it was put in and was still heating the water to 210 degrees.

That's the kind of a Heater you want.

Write for Catalogue No. 100 P.

The Whitlock Coil Pipe Co.

HARTFORD, CONN.



Cheap Heat

When feed-water gets boiling hot, more steam doesn't make it hotter—but it costs money, when it might be used for other purposes.

WEBSTER FEED-WATER HEATERS AND PURIFIERS

not being "thoroughfare" heaters, use only enough steam to heat the water. That's why they are so economical.

And that's why a million and a quarter h. p. are in use.

Warren Webster & Co.

CAMDEN, N. J.

UTILITY STEAM SPECIALTIES

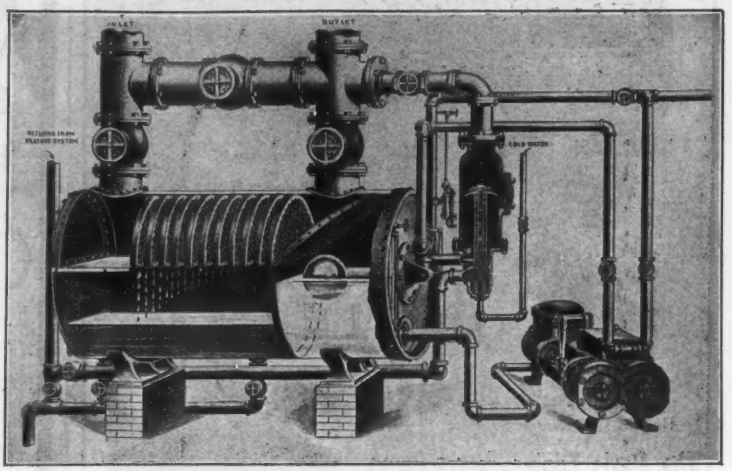
WE POINT TO WHAT
WE'VE DONE AS PROOF
THAT OIL CAN BE ENTIRELY
REMOVED FROM EXHAUST STEAM
AND THAT FEED WATER CAN BE HEATED
ABOUT TO THE TEMPERATURE OF THE EXHAUST

BY

OUR "UTILITY" COMBINATION

We can always guarantee an elimination of 98% at the outlet point of separator. We average over 99% and have in some cases left but $\frac{1}{100}$ of 1% of oil in the water. You can't see this amount, you can't taste it; fresh well water frequently has more oil in it, and this water can be used for fifty years in boilers without showing a trace of oil deposit. The feed water heating feature is optional but very efficient, free from back pressure and requires but little room and no floor space.

The "Utility" Combination serves as Exhaust Muffler, Oil Separator, Return Tank, Pump Governor and Feed Water Heater. It costs only about as much as a Feed Water Heater.



"UTILITY" PUMP GOVERNOR

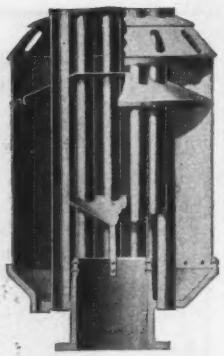
The best Pump Governor on the market. Why? Because our valve will not leak or stick, we guarantee it to absolutely govern the pump and remain tight for five years. Compare the construction of our valve with any other on the market. By adopting the "Utility" you can save coal and get a higher temperature from your heating or drying systems. Send for catalogue and list of users.

A NEW APPLICATION

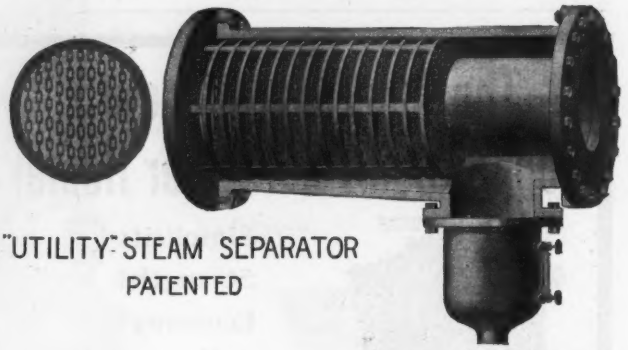
of the chain baffle plate principle which has proven so successful in the oil eliminator may be found in our

STEAM SEPARATOR

and the efficiency of it is very high. Absolutely dry steam, absolutely no back pressure. What more could you ask?



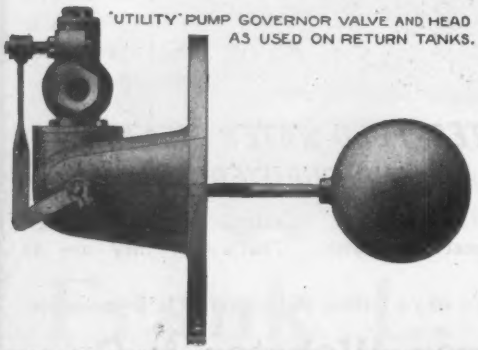
UTILITY EXHAUST HEAD
PATENTED



"UTILITY" STEAM SEPARATOR
PATENTED

ANOTHER WATER SAVER

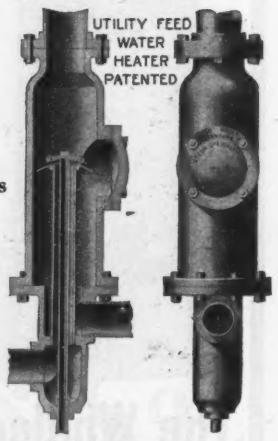
is our new Exhaust Head. Notice the great radiating surface that is given by the CIRCULATING AIR TUBES. These act as condensers, and they lessen instead of causing back pressure. Do you realize that a thousand gallons of water are wasted in a moderate sized plant which lacks an efficient exhaust head? It's so.



"UTILITY" PUMP GOVERNOR VALVE AND HEAD
AS USED ON RETURN TANKS.

WE ALSO CARRY IN STOCK

- **Back Pressure Valves**
- **Blow-off Cocks**
- **Pressure Reducing Valves**
- **High and Low Pressure Boiler Feeders**
- **Reducing Pressure Reducing Valves**
- **Boston Boiler Thermostats**
- **Steam Traps**
- **Damper Regulators**
- **Feed Water Controllers**
- **"Utility" Beam Clamps**



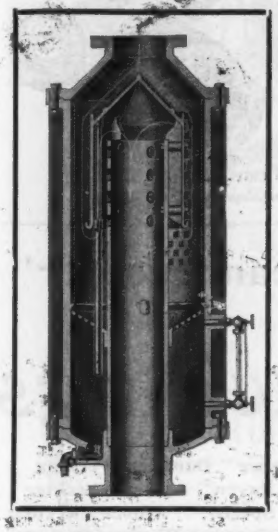
UTILITY FEED WATER HEATER PATENTED

THE STANDARD STEAM SPECIALTY CO.

542 and 544 West Broadway
NEW YORK CITY

PHILADELPHIA OFFICE, ROOM 312, BOURSE BUILDING. BELL TELEPHONE, MARKET 44-95 A

SWEETS SEPARATORS



Our steam separators deliver steam containing less than ½ of 1% of water.

Our oil separators remove 99% of the oil.

We can prove they do it and give good reasons why.

In addition they have *size* and are *machines.*

Made all styles, also make **Exhaust Heads** and **Steam Traps.**

DIRECT SEPARATOR CO.
220 Marcellus St., SYRACUSE, NEW YORK

BELT TALK

SOME MEN lace their belt so tight that it is weakened, the lacing holes tear out and their shaft is bent, just to keep it from slipping, and still it slips.

OTHER MEN use Stephenson Bar Belt Dressing and let the belt run loose, gain 25 per cent. in power, 50 per cent. in the life of the belt, keep the shaft as true as a die, and have no breakdowns.

SOME MEN say, "I don't believe such talk," and go right on wasting good belts and losing valuable power.

OTHER MEN accept our offer to send a Testing Sample Bar Free, and then are convinced. We would like to send you a testing sample bar by mail, postage paid. TRY US ONCE.

Stephenson Mfg. Co., ALBANY New York

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on Engineering or any mechanical subject.
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You will find them easy to get, just show the paper to your engineer friends and tell them how good it is, they will do the rest.

Address

THE PRACTICAL ENGINEER
46 N. Twelfth St., Philadelphia, Pa.

THE BAUM SEPARATOR

For Live and Exhaust Steam

Horizontal Style for Live Steam or Oil Service

RESULTS GUARANTEED

For condensing systems use the BAUM VACUUM STYLE OIL EXTRACTOR.

Most Satisfactory Separator on the market. *Ask why.*

Vacuum Style Oil Extractor

The Baum Separator and Machine Company
READING, PA., U. S. A.
Philadelphia Agents, AMERICAN SUPPLY CO., 612 Betz Building

BERRYMAN

Feed Water Heaters and Purifiers

WATER-TUBE AND STEAM-TUBE

Cast Iron or Steel Shells. "∩" Shaped Seamless Drawn Brass Tubes

WE BUILD HEATERS FOR EVERY PURPOSE AND CONDITION

THE KELLEY PATENT
Improved Berryman Water Tube Feed Water Heater and Purifier

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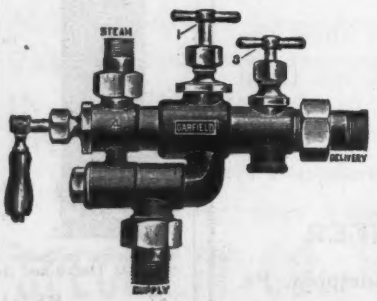

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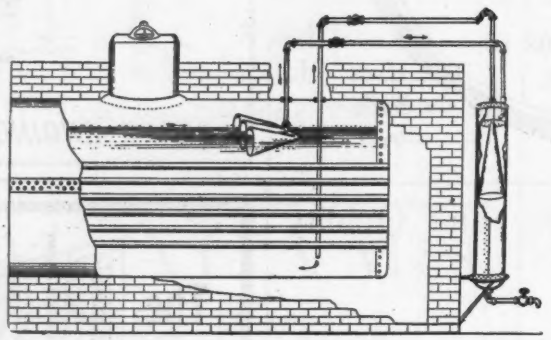

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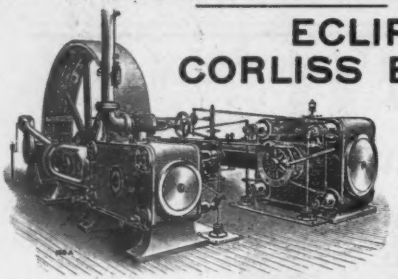

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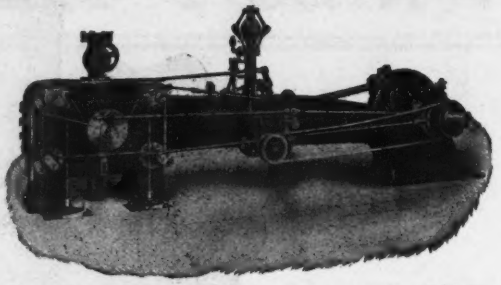

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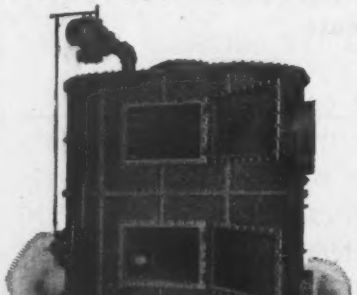

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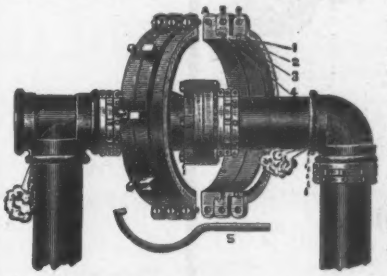

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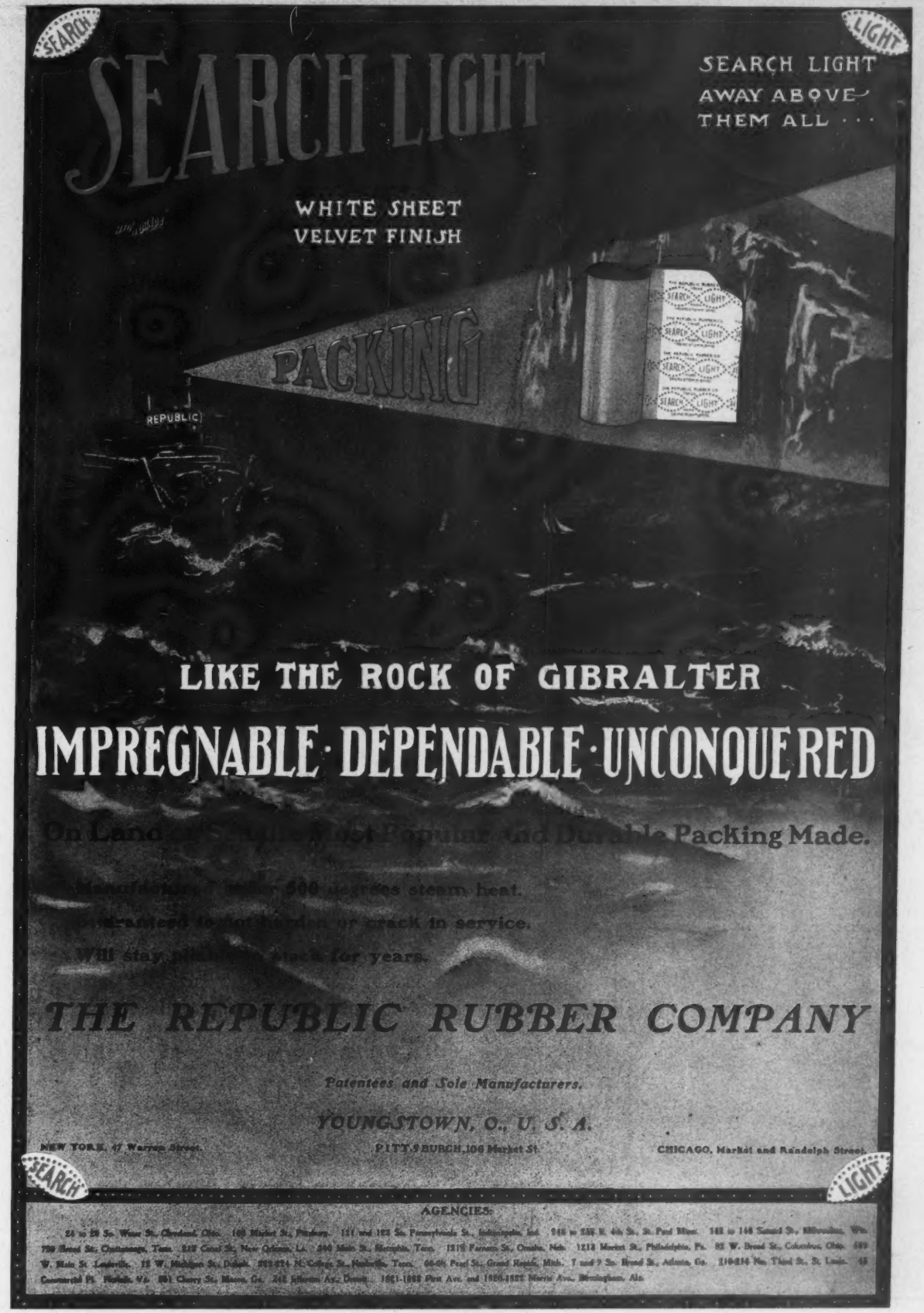
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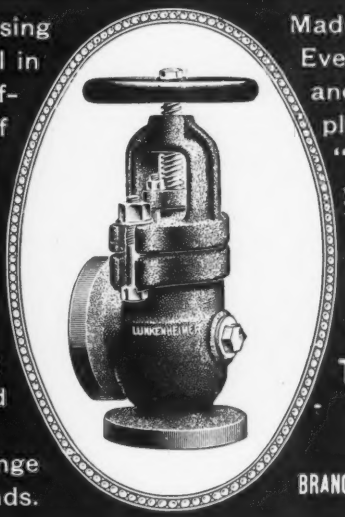

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